California High-Speed Rail Authority

RFP No.: HSR 14-32

Request for Proposals for Design-Build Services for Construction Package 4

Reference Material, Part C.1
Floodplain Impact Report

Note: Southern limit of CP4 ends just north of Poplar Ave, at approximately station WS1 5880+00, even though this document shows the limit just north of 7th Standard Road. Work south of the contract limit of WS1 5880+00 should not be considered as part of the contract

RFP No. HSR 14-32 – INITIAL RELEASE - 05/27/2015

CALIFORNIA HIGH-SPEED TRAIN

Engineering Report

RECORD SET 15% DESIGN SUBMISSION

Fresno to Bakersfield

Floodplain Impact Report

December 2013

RFP No. HSR 14-32 – INITIAL RELEASE - 05/27/2015

CALIFORNIA
High-Speed Rail Authority

Record Set 15% Design Submission Floodplain Impact Report

Prepared by:

URS/HMM/Arup Joint Venture

December 2013

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Abbreviations

AREMA	American Railway Engineering and Maintenance-of-Way Association
Authority	California High-Speed Rail Authority
BFE	base flood elevation
Caltrans	California Department of Transportation
CDFG	California Department of Fish and Game
C.F.R.	Code of Federal Regulations
CHSTP	California High-Speed Train Project
CVFPB	Central Valley Flood Protection Board
CVFPP	Central Valley Flood Protection Plan
CVRWQCB	Central Valley Regional Water Quality Control Board
CWA	Clean Water Act
DFIRM	Digital Flood Insurance Rate Map
DWR	Department of Water Resources
EIR/EIS	Environmental Impact Report/Statement
EPA	United States Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMFCD	Fresno Metropolitan Flood Control District
FRRP	Flood Risk Reduction Project
HDM	Highway Design Manual
HEC	Hydraulic Engineering Circular
HST	high-speed train
HU	Hydrologic Unit
KRCD	Kings River Conservation District
MS4	Municipal Separate Storm Sewer Systems
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
RWQCB	Regional Water Quality Control Board
SR	State Route
SWRCB	State Water Resources Control Board
TMDL	Total Maximum Daily Loads
USACE	United States Army Corps of Engineers
U.S.C.	United States Code
WSE	water surface elevation

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Section 1.0
Introduction

1.0 Introduction

1.1 Project Overview

In 1996, the state of California established the California High-Speed Rail Authority (Authority). The Authority is responsible for studying alternatives to construct a rail system that will provide intercity high-speed train (HST) service on over 800 miles of track throughout California. This rail system will connect the major population centers of Sacramento, the San Francisco Bay Area, the Central Valley, Los Angeles, the Inland Empire, Orange County, and San Diego. The Authority is coordinating the project with the Federal Railroad Administration. The California High-Speed Train Project (CHSTP) is envisioned as a state-of-the-art, electrically powered, high-speed, steel-wheel-on-steel-rail technology that will include state-of-the-art safety, signaling, and automated train-control systems.

The statewide CHSTP has been divided into a number of sections for the planning, environmental review, coordination, and implementation of the project. This Floodplain Impact Report is focused on the section of the CHSTP between Fresno and Bakersfield, specifically between the CHSTP stations in downtown Fresno and downtown Bakersfield. During the initial planning process, the CHSTP alignment alternatives are dynamic and subject to revision.

1.2 Project Description

1.2.1 Fresno to Bakersfield High-Speed Train Section

The proposed Fresno to Bakersfield (FB) Section of the HST is approximately 114 miles long and traverses a variety of land uses, including farmland, large cities, and small cities. The FB Section includes viaducts and segments where the HST will be on embankment or in cut. The route of the FB Section passes by or through the rural communities of Bowles, Laton, Armona, and Allensworth and the cities of Fresno, Hanford, Selma, Corcoran, Wasco, Shafter, McFarland, and Bakersfield.

The FB Section extends from north of Stanislaus Street in Fresno to the northernmost limit of the Bakersfield to Palmdale Section of the HST at Oswell Street in Bakersfield.

1.2.2 Alignments

The FB HST Section, shown in Figure 1.2-1, is a critical link connecting the northern HST sections of Merced to Fresno and the Bay Area to the southern HST sections of Bakersfield to Palmdale and Palmdale to Los Angeles. The FB Section includes HST stations in the cities of Fresno and Bakersfield, with a third potential station in the vicinity of Hanford. The Fresno and Bakersfield stations are this section's project termini.

The FB Section of the HST is divided into 10 subsections, most of which have multiple alternative alignments. Table 1.2-1 and Figure 1.2-1 illustrate the subsections and their corresponding alignments.

Table 1.2-1
Fresno to Bakersfield Alignment Subsections

Alignment Prefix	Alignment Subsection Name	Location		County	Corresponding EIR/EIS Alternative
		Begin	End		
F1	Fresno	San Joaquin St	E Lincoln Ave	Fresno	BNSF
M	Monmouth	E Lincoln Ave	E Kamm Ave	Fresno	BNSF
H	Hanford	E Kamm Ave	Iona Ave	Fresno and Kings	BNSF (Hanford East)
HW	Hanford West Bypass	E Kamm Ave	Idaho Ave		Hanford West Bypass 1 & 2
HW2	Hanford West Bypass	E Kamm Ave	Iona Ave		Hanford West Bypass 1 & 2 Modified
K1	Kaweah	Idaho Ave	Nevada Ave	Kings	Hanford West Bypass 2 (at-grade) (connects to C1 [Corcoran Elevated] or C2 [Corcoran Bypass])
K2		Idaho Ave	Nevada Ave		Hanford West Bypass 1 (at-grade) (connects to C3 [BNSF through Corcoran])
K3		Iona Ave	Nevada Ave		BNSF (Hanford East) (connects to C3 [BNSF through Corcoran])
K4		Iona Ave	Nevada Ave		BNSF (Hanford East) (connects to C1 [Corcoran Elevated] or C2 [Corcoran Bypass])
K5		Iona Ave	Nevada Ave		Hanford West Bypass 2 Modified (below-grade) (connects to C1 [Corcoran Elevated] or C2 [Corcoran Bypass])
K6		Iona Ave	Nevada Ave		Hanford West Bypass 1 Modified (below-grade) (connects to C3 [BNSF through Corcoran])
C1	Corcoran	Nevada Ave	Ave 128	Kings and Tulare	Corcoran Elevated
C2	Corcoran Bypass	Nevada Ave	Ave 128		Corcoran Bypass
C3	Corcoran	Nevada Ave	Ave 128		BNSF (through Corcoran)
P	Pixley	Ave 128	Ave 84	Tulare	BNSF
A1	Allensworth Bypass	Ave 84	Elmo Hwy	Tulare and Kern	Allensworth Bypass
A2	Through Allensworth	Ave 84	Elmo Hwy		BNSF (through Allensworth)

Alignment Prefix	Alignment Subsection Name	Location		County	Corresponding EIR/EIS Alternative
		Begin	End		
L1	Poso Creek	Elmo Hwy	Whisler Rd	Kern	Allensworth Bypass (connects to BNSF [through Wasco-Shafter])
L2		Elmo Hwy	Poplar Ave		Allensworth Bypass (connects to Wasco-Shafter Bypass)
L3		Elmo Hwy	Whisler Rd		BNSF (through Allensworth) (connects to BNSF [through Wasco-Shafter])
L4		Elmo Hwy	Poplar Ave		BNSF (through Allensworth) (connects to Wasco-Shafter Bypass)
WS1	Through Wasco-Shafter	Whisler Rd	Hageman Rd	Kern	BNSF (through Wasco-Shafter)
WS2	Wasco-Shafter Bypass	Poplar Ave	Hageman Rd		Wasco-Shafter Bypass
B1	Bakersfield Urban	Hageman Rd	Baker St	Kern	BNSF (Bakersfield North)
B2	Bakersfield Urban	Hageman Rd	Baker St		Bakersfield South
B3	Bakersfield Urban	Hageman Rd	Baker St		Bakersfield Hybrid

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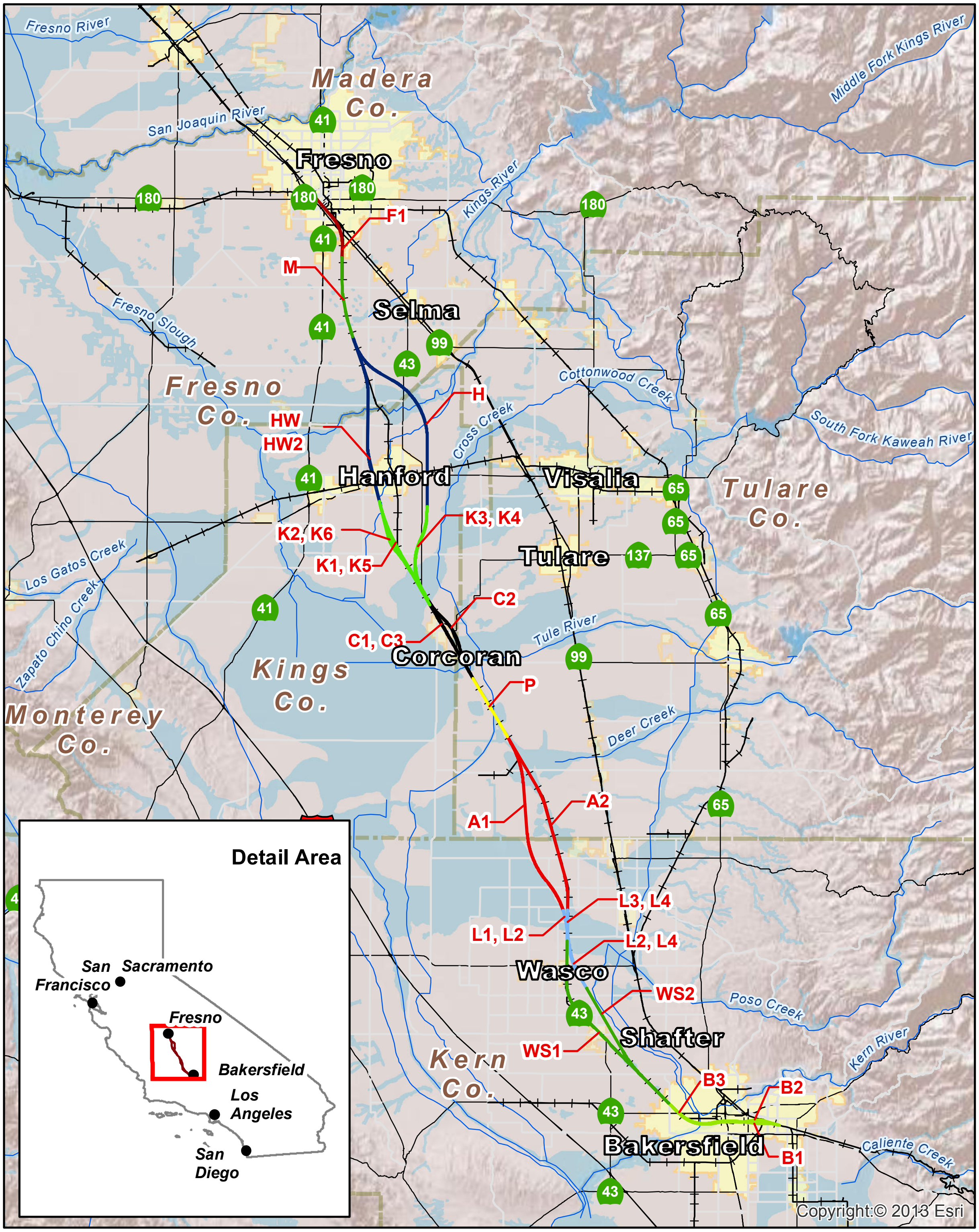

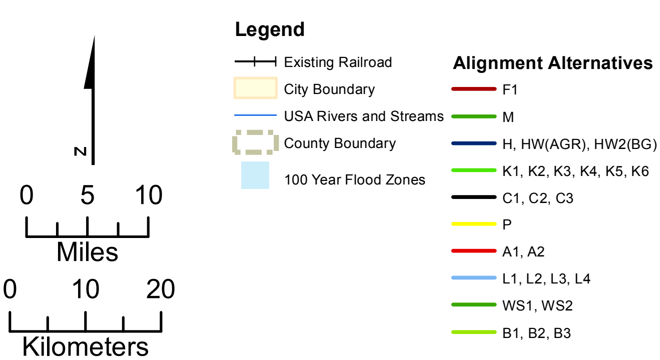

Figure 1.2-1

Alignment Overview

1.3 Purpose

This Floodplain Impact Report was prepared for the proposed water crossings located between Central Fresno and Oswell Street in Bakersfield. The purpose of this report is to accomplish the following:

- Summarize the regulatory framework pertaining to project floodplain encroachments.
- Summarize hydrologic and hydraulic design requirements for bridges and culverts.
- Identify the primary water crossings within the reach.
- Summarize preliminary hydrologic and hydraulic data and analyses that support conceptual-level water-crossing designs.
- Describe conceptual-level water-crossing hydraulic designs.
- Identify additional analyses and permits that will be needed as design progresses.

At the preliminary design level, no preferred alternative has been selected and additional alignments may still be considered. Discussions regarding hydraulics and drainage are prepared under separate cover titled *Hydrology, Hydraulics, and Drainage Report*. Discussions on stormwater quality are under a separate cover document titled *Stormwater Quality Management Report*.

1.4 Setting

The area has a typical Mediterranean climate. Summers are long, hot, and dry; winters are cool, moist, and relatively short (United States Army Corps of Engineers [USACE] 1996). Annual rainfall in the area from Fresno to Bakersfield ranges between 5.5 and 10.5 inches (Western Regional Climate Center 2010), with the majority of the precipitation occurring between November and April. Runoff events correspond to rainfall and snowmelt (USACE 1996). Three types of storms produce precipitation in the area: general winter storms, thunderstorms, and tropical cyclones called the "pineapple express." Flooding is most often caused by high intensity rainfall during general winter storms, and severe flooding can result from tropical cyclones.

The Central Valley is fairly level, with slopes commonly less than 1%. Natural vegetation is somewhat sparse; however, most of the land area is dedicated to heavy agricultural production. Due to the generally low rainfall in this portion of the Central Valley, agriculture is heavily dependent on a vast network of irrigation canals that crisscross the valley floor. Both irrigation flows and stormwater are conveyed through the irrigation network, as well as by natural streams.

Land uses near the project include a mixture of agricultural, open space, residential, commercial, industrial, railroad, highway, and flood control uses. Soils in the valley tend to be sands and silty sands.

Future climate change in the Central Valley is a possibility. The California Water Plan notes that climate change has been observed in the average Sierra Nevada snowpack decreasing by approximately 10% during the last century, the sea level rising 7 inches along California's coast, peak natural flows increasing over the last 50 years on many of the state's rivers, and many Southern California cities experiencing their lowest recorded annual precipitation twice within the past decade (California Department of Water Resources [DWR] 2009).

1.4.1 Watersheds

The project is within the Tulare Lake Basin, which has a drainage area of 17,400 square miles (Central Valley Regional Water Quality Control Board [CVRWQCB] 2004). The Tulare Lake Basin is drained by the ephemeral Kings, Kaweah, Tule, and Kern Rivers, which flow to the dry beds of Tulare, Buena Vista, and Kern Lakes. Before agricultural development, the Tulare Lake Basin was dominated by four large, shallow, and mainly temporary inland lakes. The Tulare Lake bed, which was the most northerly lake of the four, has been turned into a system of approximately 103 miles of levees and irrigation canals to direct flooding away from farmed tracts of land (USACE 1996). The Kern River once flowed south and

west across the southern portion of the valley through a complex system of sloughs, creeks, ponds, and permanent wetlands, feeding Buena Vista and Kern lakes.

> Because of the extensive agriculture diversions, Tulare Lake has been primarily being dry since the end of the 19th century — except for a few rare, major flood events whereby the lake temporarily impounds runoff from these watersheds, sometimes with sufficient volume to discharge excess surface water northward into the San Joaquin River (DWR 2009).

The Tulare Lake Basin comprises a portion of RWQCB Central Valley Region 5, including all of Kings and Tulare Counties and portions of Fresno and Kern Counties. Of the 10 subwatersheds in Region 5, the South Valley Floor subwatershed covers most of the section from Fresno to Bakersfield. DWR has defined and numbered surface water hydrologic units (HU) throughout the state to better manage both studies and capital improvements on a watershed and subwatershed basis. The HUs within the Fresno to Bakersfield Section have been defined and numbered by DWR and RWQCB as part of the South Valley Floor subwatershed: 51, 57, and 58 (see Figure 1.4-1).

1.4.1.1 South Valley Floor Subwatershed Hydrologic Unit 51

South Valley Floor Subwatershed HU 51 includes approximately 1,848,000 acres throughout Fresno, Kings, and Tulare Counties. HU 51 is bounded by the San Joaquin River Hydrologic Basin to the north, HU 52 (Kings River HU) and 53 (Kaweah River HU) to the east, HU 58 to the south, and HU 59 (Coast Range HU) to the west. HU 51 includes the City of Fresno.

The San Joaquin and Kings Rivers are the two principal rivers within or bordering the subwatershed. Fresno Slough and James Bypass on the western side of the subwatershed connect the Kings River with the San Joaquin River. The San Joaquin River has continuous flow, while Kings River, Fresno Slough, and James Bypass are ephemeral. Major engineered features include the California Aqueduct.

1.4.1.2 South Valley Floor Subwatershed Hydrologic Unit 57

South Valley Floor Subwatershed HU 57 includes 853,000 acres in Kern County. HU 57 is bounded by HU 58 to the north, HU 56 (Grapevine HU) to the south and east, and RWQCB Region 3 to the west. HU 57 includes the city of Bakersfield. Hydrologic features include Kern River, Lake Webb, and the Pioneer, Buena Vista, Stine, Sunset, and Kern Island Canals. Major engineered features include the California Aqueduct.

1.4.1.3 South Valley Floor Subwatershed Hydrologic Unit 58

South Valley Floor Subwatershed HU 58 includes 2,569,000 acres throughout Fresno, Kings, Tulare, and Kern Counties. HU 58 is bounded by HU 51 and HU 59 to the north, HU 53 and HU 55 (Southern Sierra HU) to the east, HU 57 to the south, and RWQCB Region 3 to the west.

Major rivers and streams in the subwatershed include the Kaweah, Tule, St. Johns, and Kern Rivers, and Cross and Poso Creeks. The west-flowing Tule River, Deer Creek, and the White River are also major drainages in the subwatershed, which discharge into the Tulare lakebed. Deer and Poso Creeks and the Kaweah, St. Johns, Kern, Tule, and White Rivers are ephemeral. Major engineered features include the Friant Kern Canal and the California Aqueduct.

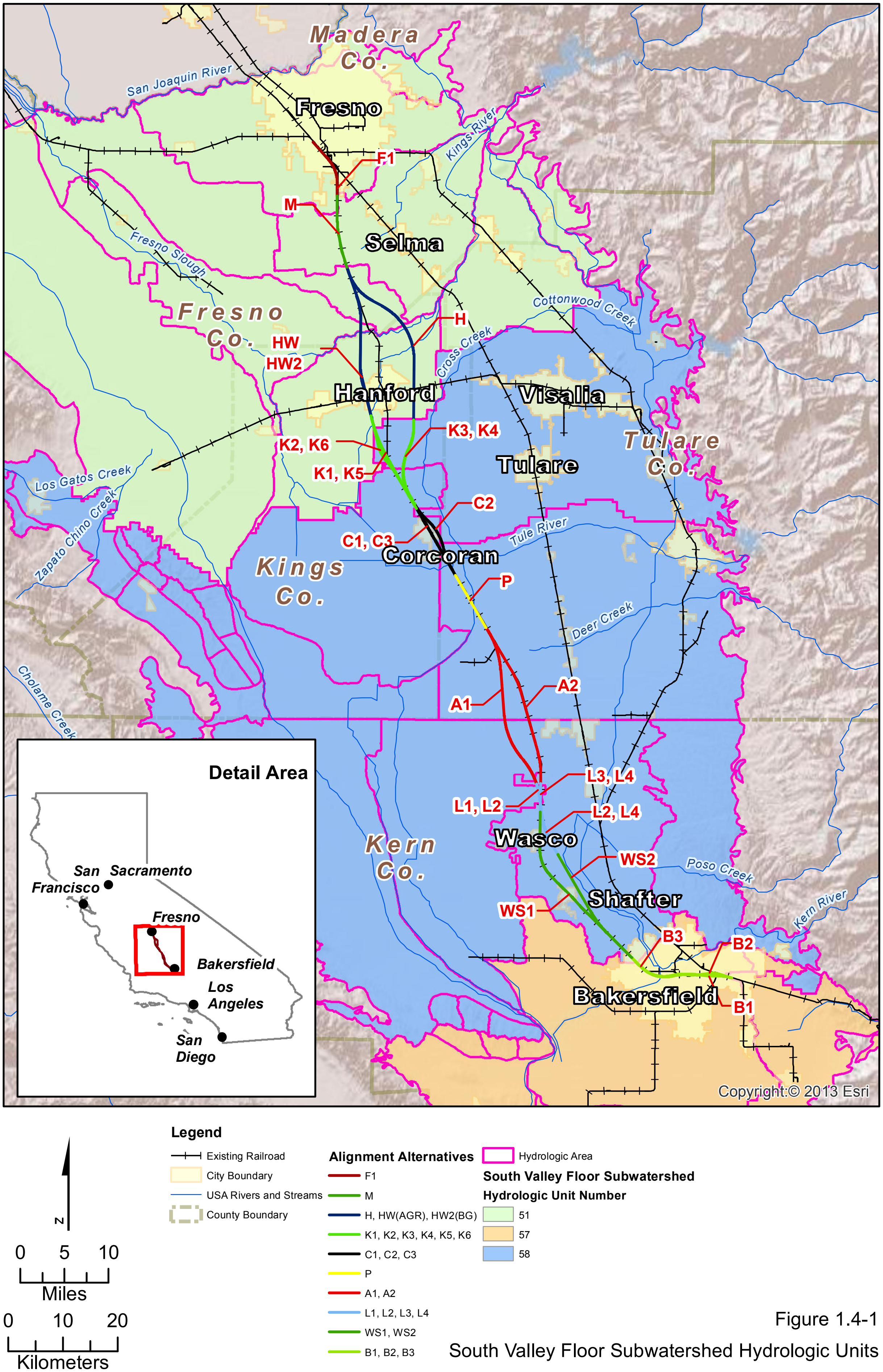

Figure 1.4-1

South Valley Floor Subwatershed Hydrologic Units

1.4.2 Regional Features

1.4.2.1 Local Jurisdictions

The Fresno to Bakersfield Section passes through the following local jurisdictions:

- City of Fresno.
- Fresno County.
- Kings County.
- City of Hanford.
- City of Corcoran.
- Tulare County.
- Kern County.
- City of Wasco.
- City of Shafter.
- City of Bakersfield.

In general, urban areas have existing storm drain facilities that capture and convey surface runoff in the project area. Information on specific local and municipal drainage system design standards for some local jurisdictions is provided below. Additional information will be obtained during later stages of design as local agencies are met with.

County and City of Fresno

The Fresno Metropolitan Flood Control District (FMFCD) provides flood control, urban drainage, and groundwater resource management services within a 400-square-mile watershed located between the Kings River Complex and San Joaquin River. The major FMFCD facilities consist of three reservoirs, five regional flood detention basins, urban basins, and natural and constructed channels (FMFCD 2009). Within Fresno, stormwater runoff is collected in surface drainage structures, pipes, channels, pumps, etc., and transported to basins for storage. Runoff is ultimately either infiltrated or discharged to irrigation channels running through Fresno. The FMFCD owns and operates more than 150 basins in the Fresno area. There are portions of the downtown Fresno area system independent of the FMFCD system and the sole property of the City of Fresno, California Department of Transportation (Caltrans), or private owners, although all discharge to the FMFCD system.

Kings County

The County of Kings, State of California, Improvement Standards (Kings County 2003) should be referenced when detailed drainage design is performed in Kings County.

City of Hanford

The city of Hanford has a stormwater system with over 180 acres of drainage basins. The city also has a new pump station that discharges treated effluent to the Lakeside Ditch Company.

City of Corcoran

In the city of Corcoran, the stormwater system primarily consists of street drainage; however, the system does include lift stations in addition to underground trunk lines for stormwater flows. The system drains to four retention ponds. The system utilizes the Corcoran Irrigation District Canal along Sherman Avenue and Dairy Avenue to carry stormwater flows to the stormwater pond located on Oregon Avenue. The City also utilizes a canal built in 2008 on the west side of the city to convey stormwater flows to a new stormwater pump station on Ottawa Avenue.

Tulare County

Drainage system design for the HST in Tulare County will reference the Improvement Standards of Tulare County (Tulare County 1991).

Kern County

The County of Kern, State of California, Development Standards (Kern County 2010) should be referenced during the detailed design of drainage systems related to the HST in Kern County.

Cities of Wasco and Shafter

The cities of Wasco and Shafter both have stormwater systems. The objectives pertaining to drainage in Shafter, as outlined in the City of Shafter General Plan (City of Shafter 2005a), should be followed during detailed drainage design. Some guidance on drainage design may also be obtained from the City of Shafter Subdivision Engineering and Design Manual (City of Shafter 2005b).

City of Bakersfield

The majority of stormwater runoff in Bakersfield is currently directed to detention basins, with the remainder directed to the Kern River or various canals. Discharges to the Kern River and canals are required to comply with the Tulare Lake Basin Plan.

1.4.2.2 BNSF Railroad

The BNSF railroad consists of 32,000 miles of track spanning the United States and Canada. The BNSF rail line operates year round and transports more than five million shipments annually. The tracks are placed on pervious material (ballast) and elevated approximately 5 feet above grade according to the BNSF Standard Plans (BNSF Railway Company 2007). According to BNSF standards, drainage ditches are located on both sides of the track with a minimum depth of 1 foot and side slopes ranging from 2 horizontal to 1 vertical ratio (2H:1V) to 9H:1V.

Along the BNSF rail line from Fresno to Bakersfield are numerous drainage crossings, including canals that carry irrigation and agricultural drainage, riverine, and cross drainage flows. Larger waterways and canals are typically spanned by bridges or conveyed under the railway by a series of large box culverts. Smaller drainages, minor canals, and cross drainage are conveyed in one or more pipe culverts.

1.4.2.3 Irrigation and Agricultural Drainage Canals

A number of local water supply, flood control, sanitation, and irrigation districts have agricultural water supply, storage, conveyance, and groundwater banking infrastructure that crosses the proposed HST alignments from Fresno to Bakersfield. The districts identified at this time include the following:

Alpaugh Irrigation District
Angiola Water District
Arvin-Edison Water Storage District
Cawelo Water District
City of Corcoran Public Works
City of Fresno Service Area
City of Hanford Public Works
City of Wasco Public Works
Consolidated Irrigation District
Corcoran Irrigation District
Cross Creek Flood Control District
Delano-Earlimart Irrigation District
Kern Delta Water District
Kings County Water District
Kings River Conservation District
Laguna Irrigation District
Lakeside Irrigation Water District
Liberty Water District
Lower Tule River Irrigation District
Melga Canal Company
North Kern Water Storage District
North of the River Sanitary District
Pixley Irrigation District
Rosedale-Rio Bravo Water Storage District

Fresno Irrigation District
Fresno Metropolitan Flood Control District
JG Boswell Water District
Kaweah Delta Water Conservation District
Kern County Water Agency Improvement District No. 4
Semitropic Water Storage District
Shafter-Wasco Irrigation District
Southern San Joaquin Municipal Utility District
Tulare Irrigation District

Within the Fresno-Bakersfield region, canals typically provide irrigation water from riverine diversions during the agricultural planting season and stormwater during the wet season. Such channels often have little to no slope so that water can be moved in either direction. The more significant channels that will intersect the proposed alignments were identified from existing mapping and are listed below:

"A" Ditch
American Colony Canal
Arvin Edison Canal
Bakker Ditch
Blowers Ditch
Calloway Canal
Carrier Canal
Central Canal
Cross Valley Canal
Crosscut Waste
Davis Ditch
East Branch Lakeside Canal
East Branch Peoples Ditch
East Main Last Chance Ditch
East Side Canal
Elkhorn Ditch
Fresno Colony Canal
Friant-Kern Canal
Grant Canal
Hardwick Ditch
Harlan Stevens Ditch
Iowa Ditch
Kern Island Canal
Lakeland Canal
Lakeside Ditch Branches
Liberty Canal
Liberty Ditch
Lone Oak Canal
Melga Canal
Murphy Slough
New Deal Canal
North Central Canal
North Corcoran Ditch
Oleander North Branch Canal
Oleander South Branch Canal
Peoples Ditch
Riverside Ditch
Stine Canal
Sweet Canal
Taylor Canal
Washington Colony Canal
W. Br. Oleander Canal
West Branch Lakeland Canal
West Main Last Chance Ditch
Wristen Ditch/Kirby Ditch

1.4.2.4 Levee Systems

The HST will cross some natural rivers and channels with levee systems.

Three of the levees at the Kings River Complex (Cole Slough/Dutch John Cut/Kings River) are State-Federal Project levees under the jurisdiction of USACE, the Kings River Conservation District (KRCD), and Central Valley Flood Protection Board (CVFPB). Construction of the HST over these levees will require USACE approval. The CHSTP will aim to avoid impacting the USACE jurisdictional levees at the Kings River Complex.

The levees at Cross Creek within the project area are not USACE jurisdictional levees; however, the levees west of BNSF along Cross Creek and Tule River, outside of the project area, are under USACE jurisdiction. These levees were constructed in 1983 during an emergency situation to protect Corcoran from Tulare Lake flooding. These levees do not meet Federal Emergency Management Agency (FEMA) certification criteria and were not utilized in FEMA hydraulic study.

Church Avenue, Central Canal, County Line Creeks, and Poso Creek have no levees. There is a levee along the south side of the Kern River, but it is not under USACE jurisdiction.

1.5 Regulatory Framework

This section outlines the federal, state, and regional agencies and guidelines that may apply to hydrology, hydraulics, and drainage design within the project area.

1.5.1 Federal Guidance

1.5.1.1 National Flood Insurance Act

Title 42 United States Code (U.S.C.) Section 4001 et seq.

The National Flood Insurance Act requires the purchase of insurance for buildings in special flood-hazard areas. The act is applicable to any federally assisted acquisition or construction project in an area identified as having special flood hazards. Projects should avoid construction of buildings in flood-hazard areas identified by FEMA.

FEMA identifies flood-prone areas, regulates development in floodplains, provides inundation mapping on flood insurance rate maps (FIRMs) as part of the National Flood Insurance Program for each community, and provides federally backed flood insurance to homeowners, renters, and business owners. Typically, each county has a flood insurance study (FIS) completed and FEMA works with participating communities to develop FIRMs. The FIRMs divide communities into special flood hazard zones and other areas. Special flood hazard zones are areas inundated by a base, 100-year recurrence interval flood (i.e., 1% chance of annual flooding and 26% chance of flooding over a 30-year period). Special flood hazard zones are further classified by the hydraulic analysis approaches and the level of detail used in delineating the base flood boundaries and determining elevations. Special flood hazard zone classifications are defined in Table 1.5-1.

If a project will substantially alter the extent or depth of the base flood, the project owner must submit supporting documentation and modeling of changed condition. If FEMA approves the development proposal, it issues a Conditional Letter of Map Revision (CLOMR). After construction is complete, as-built construction plans and modeling are submitted to FEMA, and it issues a Letter of Map Revision (LOMR), which officially updates the FIRM.

Within the Fresno to Bakersfield Section, FEMA has conducted detailed flooding studies for Cross Creek, Kern River, and one area within the City of Fresno (Church Street, designated as "Zone AH").

Other delineated floodplain areas for this section include the Kings River Complex, Tule River, Deer Creek, two unnamed watercourses at the Tulare-Kern County border (referred to in this report as County Line Creeks), and Poso Creek. These flood-prone areas are generally designated "Zone A" by FEMA, indicating a floodplain for which FEMA has determined approximate inundation areas but without detailed flow or water surface elevation (WSE) information.

Table 1.5-1
Special Flood Hazard Zones

Zone	Description
A	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations (BFEs) are shown within these zones.
AE	Areas with 1% annual chance of flooding. The base floodplain where FEMA BFEs are provided. AE zones are now used on new format FIRMs instead of A1–A30 zones.
AH	Areas with a 1% annual chance of shallow flooding, usually in the form of a pond, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. BFEs derived from detailed analyses are shown at selected intervals within these zones.
AO	River or stream flood hazard areas and areas with a 1% or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Average flood depths derived from detailed analyses are shown within these zones.

Zone	Description
AR	Areas with a temporarily increased flood risk due to the building or restoration of a flood control system (such as a levee or a dam). Mandatory flood insurance purchase requirements apply, but rates do not exceed the rates for unnumbered A zones if the structure is built or restored in compliance with zone AR floodplain management regulations.
A99	Areas with a 1% annual chance of flooding that will be protected by a federal flood control system under construction, where construction has reached specified legal requirements. No depths or BFEs are shown within these zones.
A1 through A30[1]	These are known as numbered A zones (e.g., A7 or A14). This is the base floodplain where the FIRM shows a BFE.
[1]Floodplain Zone Designation in old FEMA format	

1.5.1.2 Rivers and Harbors Act

Protection of Improvements to Navigable Waters
Title 33 U.S.C. Section 403 et seq.

Section 403 of the Rivers and Harbors Act (commonly known as Section 10), administered by the USACE, requires permits for all structures such as pilings, docks, or bridges that are constructed in navigable waters of the United States. Excavation or fill activities such as dredging and placement of fill or riprap in the waterways also require permits. Navigable waters include waters that are subject to the ebb and flow of the tide and rivers used as a means of interstate transport or foreign commerce. USACE grants or denies permits based on the impacts on navigation. Under this definition, the Fresno to Bakersfield Section of HST will not impact navigable waters of the United States. Section 404 of the Clean Water Act (CWA) also covers most of these activities.

Use of Harbor or River Improvements
Title 33 U.S.C. Section 408

Modification of a federal flood control project requires permission by USACE through a Title 33 U.S.C. Section 408 permit. Section 408 specifies the technical and risk analyses that must be submitted to USACE by any nonfederal sponsor of a project that may adversely affect the capacity or structural integrity of a federal flood control facility. The types of information required include detailed structural information, hydraulic data (e.g., water surface profiles), and geotechnical evaluations (e.g., levee seepage and stability). A memorandum, Clarification Guidance on the Policy and Procedural Guidance for the Approval of Modifications and Alterations of Corps of Engineers Projects (USACE 2008), provides detailed information.

A Congressional Briefing Paper (California Water Commission 2011), *Proposed Framework for Guidance Clarifying the U.S. Army Corps of Engineers Section 408 Review Process for Local Funded and Constructed Improvements to Federal Flood Control Projects*, uses the terms "Major 408" and "Minor 408":

- Minor 408s are activities that (i) were previously approved in accordance with Section 208.10 or (ii) go further than simple operations and maintenance but restore "the authorized level of protection or improve the structural integrity of the protection system that do not change the authorized structural geometry or hydraulic capacity that were previously approved in accordance with Section 208.10."
- Major 408s include all degradations, raisings, realignments, and other alterations/modifications not approvable as a Minor 408.

CHSTP improvements will be designed to avoid the need for a Major Section 408 permit.

In January 2013, USACE released a revised general guidance, Minor Section 408 Modification Guidance (USACE 2013). This guidance provides Minor Section 408 submittal requirements for engineering, operation, and maintenance aspects of construction within the critical area of Flood Risk Reduction Project (FRRP) constructed by USACE and those FRRP in the USACE Public Law 84-99 Rehabilitation and Inspection Program. Where construction is concerned, the critical area for a levee is generally defined as 300 feet riverward to 500 feet landward of the levee's centerline. The review schedule for a Minor Section 408 is six to eight weeks. Local sponsors are the owners of the FRRP and are responsible for controlling all construction activity that occurs within the critical area. No reviews will proceed without permission of the local sponsor.

Local Flood Protection Works
Title 33 Code of Federal Regulations (C.F.R.) Section 208.10

Section 208.10 defines the responsibilities of the USACE for maintenance of flood channels, levees, and other flood protection features constructed by the federal government. USACE approval may be granted under Section 208.10 for alternations or improvements that have little or no impact on the authorized level of protection (capacity) and structural integrity of a federal flood protection project.

The CVFPB, which is part of the California DWR (formerly the California Reclamation Board), administers Section 208.10 in the Central Valley. CVFPB administers permits for encroachments on state and state/federal flood control projects. USACE provides a concurrent review of the technical aspects of encroachment permit applications and provides to CVFPB a list of technical requirements to satisfy USACE responsibilities under Section 208.10.

Since 2006 USACE has considered some modifications and alterations to USACE projects directly under Section 408. From June 18, 2010, Section 408 became the sole authority utilized for approvals to modify USACE projects, and the USACE Districts are authorized to approve pursuant to Section 408 those minor, low-impact modifications to flood protection works operated and maintained by non-federal sponsors that previously were being considered under 33 C.F.R. 208.10(a)(5).

1.5.1.3 Clean Water Act (Title 33 U.S.C. Section 1251 et seq.)

Permit for Fill Material in Waters and Wetlands
Title 33 U.S.C. Section 404

Section 404 of the CWA regulates the discharge of dredged and fill materials into waters of the United States, which include oceans, bays, rivers, streams, lakes, ponds, and wetlands. Emphasis is placed on protection of water quality and conservation of marine and aquatic habitat. It should be noted that under Section 404 of the CWA, the term "navigable waters" includes not only those waters identified as navigable waters of the United States by Section 10 (Rivers and Harbors Act), but also waters with "a significant nexus to navigable waters."

Projects are encouraged to avoid impacts on water bodies or to minimize impacts where a water body cannot be avoided. Projects mitigate for lost habitat, typically by providing replacement habitat at a different location. A 404 permit application must be submitted to USACE. Nationwide 404 permits exist for a large number of activities that have been determined to cause generally minor impacts. A single application typically covers the requirements of both Section 10 and Section 404 (CWA).

Clean Water Quality Certification
Title 33 U.S.C. Section 401

Under Section 401 of CWA, applicants for a federal license or permit to conduct activities that may result in the discharge of a pollutant into waters of the United States must obtain certification from the state in which the discharge would originate, or, if appropriate, from the interstate water pollution control agency with jurisdiction over affected waters at the point where the discharge would originate. Therefore, all

projects that have a federal component and may affect the quality of state waters (including projects that require federal agency approval, such as issuance of a Section 404 permit) must also comply with CWA Section 401. Section 401 certification or waiver is under the jurisdiction of the applicable RWQCB.

National Pollutant Discharge Elimination System
Title 33 U.S.C. Section 402

The CWA requires a National Pollutant Discharge Elimination System (NPDES) permit to be obtained by anyone wanting to discharge pollutants. Section 402 allows the US Environmental Protection Agency (EPA) to authorize the NPDES Permit Program to state governments, enabling states to perform many of the permitting, administrative, and enforcement aspects of the NPDES Program, while still allowing the EPA to retain oversight responsibilities.

In California, the water quality regulations under the CWA have been delegated by the EPA to the State Water Resources Control Board (SWRCB) of California and the various Regional Water Control Boards.

Section 303(d) List of Water Quality Limited Segments

The CWA requires states to identify and make a list of surface water bodies that are polluted. These water bodies do not meet water quality standards even after discharges of waste from point sources have been treated by the minimum required levels of pollution control technology. States must also prioritize the water bodies on the list and develop total maximum daily loads (TMDLs) to improve the water quality. The project-specific 303(d)-listed water bodies are discussed in Section 1.5.3.

1.5.1.4 Executive Order 11988

Executive Order 11988 directs all federal agencies to (1) avoid to the extent practicable and feasible all short-term and long-term adverse impacts associated with floodplain modification and (2) avoid direct and indirect support of development within 100-year floodplains when there is a reasonable alternative. Additional specific information must support projects that encroach on 100-year floodplains.

1.5.1.5 Floodplain Management (U.S. Department of Transportation Order 5650.2)

The U.S. Department of Transportation Order 5650.2, Floodplain Management and Protection, prescribes "policies and procedures for ensuring that proper consideration is given to the avoidance and mitigation of adverse floodplain impacts in agency actions, planning programs and budget requests." The order applies to all floodplains as shown on FEMA FIRMs with the exception of Zone C (areas of minimal flooding). Environmental review documents should indicate potential risks and impacts from proposed transportation facilities.

1.5.1.6 Federal Highway Administration

The Federal Highway Administration (FHWA) requires a floodplain report (location hydraulic study) when a proposed transportation project may encroach on a FEMA-established (100-year) flood hazard area. A similar approach to risk assessment and reporting is proposed for the HST. The minimum required content of the floodplain report must be as prescribed in Title 23 C.F.R. Section 650, as follows:

- The degree of encroachment associated with each alternative, including evaluation and discussion of the practicability of alternatives to any encroachments.
- The risks associated with implementation of the action, including potential for interruption or termination of communities, only evacuation routes, or facilities needed for emergency vehicle and the significant potential for flood-related property loss or hazard to human life.
- The impacts on natural and beneficial floodplain values.

- The support of probable incompatible floodplain development.
- The measures to minimize floodplain impacts associated with the action.
- The measures to restore and preserve the natural and beneficial floodplain values impacted by the action.
- Evaluation and discussion of the practicability of alternatives to any significant encroachments or any support of incompatible floodplain development.

The floodplain report must also discuss the mitigation measures to minimize floodplain impacts and to restore and preserve the natural and beneficial floodplain values that are impacted. This analysis will be completed during later stages of design.

Additionally, FHWA has developed numerous design manuals. Many FHWA design manuals are referenced in the Caltrans Highway Design Manual (HDM) (Caltrans 2006), and many FHWA standards have been adopted by Caltrans. Unless otherwise noted, the CHSTP has adopted Caltrans standards for hydrologic analysis and hydraulics design. Design manuals referenced for this report include the *Design of Roadside Channels with Flexible Linings Hydraulic Engineering Circular (HEC) 15* (FHWA 1988), *Urban Drainage Design Manual HEC 22* (FHWA 2001), and *Design of Bridge Deck Drainage HEC 21* (FHWA 1993).

1.5.2 State Regulations and Guidelines

1.5.2.1 Porter-Cologne Water Quality Act

California Water Code 13000 et seq.

Water quality law in California is governed by the Porter-Cologne Water Quality Act. Primarily the act assigns responsibility for water rights and water quality protection to the SWRCB and directs nine RWQCBs to develop and enforce water quality standards including responsibility for issuance of NPDES permits.

1.5.2.2 State Water Resources Control Board

The SWRCB has adopted water quality standards for the state's waters and issues permits regulating the discharge of wastes into these waters. Permits can be issued by the SWRCB or by the RWQCBs under the jurisdiction of the state board. Details of some of the discharge permits administered by the SWRCB are provided below.

Construction General Permit

On July 1, 2010, the revised General Construction Stormwater Permit took effect, issued by the SWRCB. The requirements for this permit apply to any project that disturbs 1 acre or more of land. For a project to qualify under the general permit, a Notice of Intent (NOI) must be filed with the SWRCB and a Stormwater Pollution Prevention Plan (SWPPP) must be prepared that details the erosion and sediment control measures and other pollution prevention measures that will be implemented at the project site. The SWPPP must also contain a runoff monitoring plan and measures for inspecting, maintaining, and upgrading, as necessary, the erosion control measures.

The General Construction Stormwater Permit deals with stormwater runoff leaving the project site and may also cover dewatering activities, although the individual RWQCB may have special dewatering requirements. Additional specific requirements are applied depending upon the location of a project and its perceived risk level (see section 2.3 for a discussion on project-specific risk assessment).

Dewatering and Other Low-Threat Discharges to Surface Waters

This General Order covers certain categories of dewatering and other low-threat discharges to waters of the United States, which are either four months or less in duration or have an average dry weather flow that does not exceed 0.25 million gallons per day (from Permit Number R5-2008-0081). The General Permit specifies both effluent limitations and receiving water limitations. Additional details about the permit are available at the SWRCB website: http://www.swrcb.ca.gov/centralvalley/board_decisions/adopted_orders/general_orders/r5-2008-0081.pdf.

Municipal Separate Storm Sewer Systems

A municipal separate storm sewer system (MS4) is a conveyance or system of conveyances that meets the following:

- Owned by a state, city, town, village, or other public entity that discharges to waters of the United States.
- Designed or used to collect or convey stormwater (including storm drains, pipes, ditches, etc.).
- Not a combined sewer.
- Not part of a publicly owned treatment works (sewage treatment plant).

Phase I, issued in 1990, required medium and large cities or certain counties with populations of 100,000 or more to obtain NPDES permit coverage for their stormwater discharges. Phase II, issued in 1999, required regulated small MS4s in urbanized areas, as well as small MS4s outside the urbanized areas that are designated by the permitting authority, to obtain NPDES permit coverage for their stormwater discharges. Generally, Phase I MS4s are covered by individual permits and Phase II MS4s are covered by a General Permit. Each regulated MS4 is required to develop and implement a stormwater management program to reduce contamination of stormwater runoff and prohibit illicit discharges.

Both Fresno and Bakersfield have Phase 1 MS4 NPDES permits in place, and therefore, consultation will be required in these municipalities.

1.5.2.3 California Department of Fish and Game

Lake or Streambed Alteration Agreement
California Code of Regulations Sections 1601–1603

The California Department of Fish and Game (CDFG) is responsible for, among other things, preserving and protecting aquatic and marine habitats. Under Sections 1601–1603 of the California Code of Regulations (CCR), agencies are required to notify CDFG prior to implementing a project that would substantially divert, obstruct, or change the natural flow of any river, stream, or lake. The project must submit a Notification of Lake or Streambed Alteration and notify CDFG about any action that would substantially alter the channel or streambed or deposit material within the channel. If CDFG determines that the project may adversely affect an existing fish and wildlife resource, it will issue a Lake or Streambed Alteration Agreement that lists measures that must be completed to adequately protect the resource.

1.5.2.4 California Department of Transportation

Caltrans is not a direct reviewing agency for the CHSTP; however, it has regulatory authority over those portions of the project that involve modifications to state highways. The High-Speed Rail Authority (Authority) has generally agreed to comply with Caltrans's requirements and templates, when practical. Caltrans HDM (Caltrans 2011) contains detailed information for the design of highway and road

stormwater systems. For those portions of the CHSTP that involve altering or relocating state highways, the drainage design will need to follow Caltrans HDM.

Location Hydraulic Studies

Chapter 804 of the HDM (Caltrans 2009) addresses the topic of floodplains; Section 804.7.2.e states that the results of location hydraulic studies must be summarized in the environmental document prepared for the project. A location hydraulic study is the preliminary investigation of the degree of floodplain encroachment by a project (Caltrans 2009). The study must address the following:

- Flood risks associated with the project.
- Impacts on natural and beneficial floodplain values.
- Identification of probable incompatible floodplain development.
- Measures to minimize floodplain impacts.
- Measures to restore and preserve the natural and beneficial values affected by the project.
- Evaluation of the practicality of alternatives to significant floodplain encroachment.

A significant floodplain encroachment is determined by one or more of the following:

- A significant potential for interruption or termination of a transportation facility that is an emergency vehicle route or a community's only evacuation route.
- A significant risk to life or property.
- A significant adverse impact on the natural and beneficial floodplain values.

Section 804.7 of the HDM states that the location hydraulic studies can be documented in a floodplain evaluation report attached to the project's environmental documentation. The timing of location hydraulic studies may depend in part on whether a state highway is being modified under Caltrans jurisdiction. Caltrans is not a direct reviewing agency for this project; however, the Authority has generally agreed to comply with Caltrans requirements and templates when practical.

Location hydraulic studies must be performed for each of the major floodplains identified in Table 2.1-1. The level of detail for these studies is comparable to the analysis required for development permits and should be summarized in a floodplain evaluation report appended to the final.

Environmental Impact Report/Statement

The following should be determined and developed for all relevant water bodies:

- WSE based on the 100-year design flow (or 200-year design flow).

- Map illustrating the FEMA 100-year flood limits (or DWR 200-year floodplain limits) and portions of the project and existing buildings situated within the floodplain.

- Completion of Forms 804.7A (Technical Information for Location Hydraulic Study) and 804.7B (Floodplain Evaluation Report Summary) for projects identified to have minor floodplain impacts (Section 804 of the HDM [Caltrans 2009]).

1.5.3 Regional Regulations

1.5.3.1 Central Valley Regional Water Quality Control Board

For the Fresno to Bakersfield Section, the RWQCB for the Central Valley Region, also known as Region 5, is the primary regulatory agency that will oversee conformance of the project's stormwater quality management system with the Clean Water Act. The California Water Code established the RWQCBs as the primary state agencies for protecting the quality of waters. The RWQCB developed a Tulare Lake Basin Plan, which outlines beneficial uses of water bodies as well as specific water quality objectives for

surface and ground waters. The water quality objectives include concentration limits for a large range of pollutants. Regulations for discharges within this area are included in the Water Quality Control Plan for the Sacramento and San Joaquin River Basins (California RWQCB Central Valley Region 2009).

Impaired Water Bodies and Total Maximum Daily Loads

The Fresno to Bakersfield Section drains to several water bodies listed on the 2006 State 303(d) List of Impaired Water Bodies for exotic species, selenium, electrical conductivity, molybdenum, and toxaphene. Table 1.5-2 lists details for each impaired water body within the project area. The listings carry the implication that the receiving waters have exceeded the maximum load of pollutants they can receive while still meeting water quality standards. These maximum amounts are termed TMDLs. The Federal Clean Water Act requires that programs to reduce pollutant loading be implemented for all water bodies listed on the State 303(d) list. These programs are also termed TMDLs.

Table 1.5-2
Clean Water Act Section 303(d): Listed Water Bodies and Priority Pollutants in the Project Vicinity

Name	Pollutant	Source	Status
San Joaquin River (Friant Dam to Mendota Pool) Exotic Species	Exotic species	Source unknown	TMDL required
Mendota Pool	Selenium	Agricultural return flows, agriculture, groundwater withdrawal, other	TMDL required
Kings River, Lower (Island Weir to Stinson and Empire Weirs)	Electrical conductivity	Agriculture	TMDL required
Kings River, Lower (Island Weir to Stinson and Empire Weirs)	Molybdenum	Agriculture	TMDL required
Kings River, Lower (Island Weir to Stinson and Empire Weirs)	Toxaphene	Agriculture	TMDL required
Kings River, Lower (Pine Flat Reservoir to Island Weir)	Chlorpyrifos Unknown Toxicity	Agriculture Source Unknown	TMDL required
Cross Creek (Kings and Tulare counties)	Unknown Toxicity	Source Unknown	TMDL required
Deer Creek (Tulare County)	pH (high), Unknown Toxicity	Source Unknown	TMDL required

The proposed project is not expected to contribute to exotic species, selenium, molybdenum, and toxaphene. However, heavy metals generated by the rail can potentially affect electrical conductivity.

Tulare Lake Basin Plan

Any project stormwater management plan will need to meet the requirements of the Tulare Lake Basin Plan (California RWQCB Central Valley Region 2009), which provides information on the beneficial uses and TMDLs of the receiving water bodies. Table 1.5-3 lists specific beneficial uses for each water body.

Groundwater beneficial uses are organized by detailed analysis units based on the water bodies. Surface water beneficial uses are organized by segments of the relevant water bodies.

1.5.3.2 Central Valley Flood Protection Board

California Code of Regulations Title 23, Division 1

In cooperation with USACE, the CVFPB provides policy direction and coordination for the flood control efforts of state and local agencies along the Sacramento and San Joaquin Rivers and their tributaries. CVFPB cooperates with federal, state, and local government agencies in establishing, planning, constructing, operating, and maintaining flood control works. Additionally, under Section 8609 of the California Water Code, CVFPB has the authority to designate floodways, enforce standards for the construction, maintenance, and protection of adopted flood control plans, and regulate encroachments in a floodway. By issuing permits for encroachments, CVFPB also exercises regulatory authority to maintain the integrity of the existing flood control system and designated floodways.

CVFPB has mapped designated floodways along more than 60 streams and rivers in the Central Valley. CVFPB-designated floodways are different from FEMA floodways. Designated floodways refer to the channel of the stream and that portion of the adjoining floodplain reasonably required to provide the passage of a design flood (generally the 100-year storm event); it is also the floodway between existing levees as adopted by CVFPB or the California legislature.

In addition to designated floodways, Table 8.1 in Title 23 CCR lists several hundred stream reaches and waterways as regulated streams. Projects that would encroach on a designated floodway or regulated stream, or come within 10 feet of the toe of a state/federal flood control structure (e.g., a levee), require an application (with an associated environmental assessment questionnaire) for an encroachment permit. The Kings River Complex, Cross Creek, and the Kern River are listed in Table 8.1 and are therefore under CVFPB’s purview.

CVFPB reviews encroachment permit applications for completeness and works with the applicant to ensure that all required content is submitted. CVFPB provides a copy of the application to USACE for concurrent review. In general, USACE focuses on technical engineering requirements, such as hydraulic modeling, geotechnical studies, and performance requirements to fulfill its obligations under Section 408 and Section 208.10; CVFPB focuses on environmental compliance and Title 23 standards to ensure compliance under the California Environmental Quality Act and Title 23. USACE develops a list of requirements and restrictions (e.g., maximum rise criteria demonstrated through hydraulic modeling), which append the permit. CVFPB may also develop a list of requirements and restrictions for the permit and either issue the permit with requirements and restrictions or deny the permit based on their collaborative review with USACE.

Table 1.5-3
Water Body Beneficial Uses

Water Body[1] (Name)	Tulare Lake Basin Plan Beneficial Uses[2]														303(d) Listed Pollutants
	MUN	AGR	IND	PRO	POW	REC-1	REC-2	WARM	COLD	WILD	RARE	SPAWN	GWR	FRSH	
Kings River (Peoples Weir to Stinson Weir on North Fork and to Empire Weir No. 2 on South Fork)		X				X	X	X		X			X		Electrical conductivity, molybdenum, toxaphene[3]
Cross Creek[4] (Kaweah River, Below Lake Kaweah)	X	X	X	X		X	X	X		X			X		
Tule River (Below Lake Success)	X	X	X	X		X	X	X		X			X		
Poso Creek		X				X	X	X	X	X			X	X	
Kern River (Below KR-1)	X	X	X	X	X	X	X	X		X	X		X		

Notes:

[1] Features identified from review of United States Geological Survey topographic maps and aerial photographs.

[2] Surface water beneficial uses identified in the Tulare Lake Basin Plan (Central Valley RWQCB 2004).

MUN = municipal and domestic water supply
AGR = agricultural supply
IND = industrial service supply
PRO = industrial process supply
POW = hydropower generation
REC-1 = water contact recreation
REC-2 = non-contact water recreation
WARM = warm freshwater habitat
COLD = cold freshwater habitat
WILD = wildlife habitat
RARE = rare, threatened, or endangered species
SPWN = spawning, reproduction, and/or early development
GWR = groundwater recharge
FRSH = freshwater replenishment

[3] Kings River is impaired approximately 10 miles downstream of study area (from Island Weir to Stinson and Empire Weirs). After extended wet periods, Kings River conveys water to Mendota Pool and San Joaquin River (from Friant Dam to Mendota Pool), approximately 55 miles downstream of the study area.

[4] Lake Kaweah, which provides flow to the Kaweah River and Cross Creek, is impaired approximately 50 miles upstream of study area.

1.5.3.3 Central Valley Flood Protection Act

California Water Code 9600 et seq.

DWR and CVFPB (which is part of DWR) collaborated with local governments and planning agencies, and prepared and adopted the Central Valley Flood Protection Plan (CVFPP) in mid-2012. The CVFPP is a requirement of the Central Valley Flood Protection Act of 2008, which establishes the 200-year flood event as the minimum level of flood protection in urban and urbanizing areas. The objective of CVFPP is to create a system-wide approach to flood management and protection improvements in the Central Valley.

Cities and counties must amend their general plans accordingly within 24 months of the CVFPP adoption; zoning ordinances must be amended within 36 months. Consequently, the 200-year flood event must be incorporated into city and county design standards by January 1, 2015, for new residential and nonresidential construction within flood hazard zones. By 2025, all urban areas protected by flood-control project levees must be protected from a 200-year flood event.

Under its FloodSAFE program, DWR is responsible for developing and making available maps for the 200-year floodplain (DWR 2008c). CVFPB collaborates with cities and counties to develop policies for implementing amended general plans.

1.5.4 Local Regulations

The cities and counties within the study area have regulations and manuals governing stormwater management for projects constructed within their respective jurisdictions. No contacts were made with local jurisdictions during the development of this Stormwater Quality Management Report. Stormwater requirements have changed significantly at the state level, and it is expected that the requirements of the local jurisdictions will need to be modified in the near future to comply with state requirements. It is recommended that public works department officials from each of the jurisdictions be contacted and interviewed for the purpose of acquiring up-to-date information on local stormwater regulations and manuals.

1.6 Other Standards

1.6.1 American Railway Engineering and Maintenance-of-Way Association

The American Railway Engineering and Maintenance-of-Way Association (AREMA) publishes standards and best practices for railway engineering. The *Manual for Railway Engineering* is an annual publication released by AREMA. It contains principles, data, specifications, plans, and economics pertaining to the engineering, design, and construction of the fixed plant of railways (except signals and communications) and allied services and facilities. Portions of Volume One of the AREMA manual pertain to drainage standards.

Section 2.0

Floodplains, Impacts, and Potential Mitigation

2.0 Floodplains, Impacts, and Potential Mitigation

In this report, flood hazard areas identified by FEMA are used to determine locations where floodplain impacts of the proposed HST warrant consideration of mitigation. The FISs for Fresno, Kings, Tulare, and Kern Counties summarizing flood problems and anecdotal information from irrigation districts and cities have also helped identify local areas prone to flooding. While dam failure is a potential mode of flooding in the area, a treatment of this risk is considered beyond the scope of the preliminary engineering design.

Although an extensive flood control system has been constructed in the region, large portions of the Central Valley are considered to be flood hazard areas. This threat is mainly from riverine flooding and ponding on the flat valley floor. The San Joaquin Valley and Tulare Lake basin are relatively flat with broad, shallow floodplains that are either uncontained or are uncontained at higher flows due to levee overtopping. Therefore, the WSE is not expected to increase greatly as the flow rate increases. For example, the difference between the 100- and 200-year storms may be less than 1 foot in elevation. In the vicinity of the proposed alignments, a significant factor contributing to the size of the floodplains is the existing BNSF railway embankment, which acts as an impediment to water moving from east to west toward the Tulare Lake basin.

A variety of structures provide flood control in the study area. Some of these flood control structures were constructed as part of state/federal flood control projects that were funded by either the state of California or the federal government. When funded by the federal government, the state assumed responsibility for operations and maintenance (O&M) after completion and exempted the federal government from any related claims for damages. Statewide, project flood-control facilities consist of 1,569 miles of levees, hundreds of miles of improved flood channels, and 56 major flood control works (California DWR 2010). CVFPB has responsibility for O&M of project flood control facilities in the Central Valley. In many cases, CVFPB has turned over O&M to local flood and levee districts under its jurisdiction. The exception to this is at the Kings River Complex. The KRCD has been contracted directly by the USACE to perform O&M activities on the portion of the Kings River between Kingsburg, SR 41 (South Fork of the Kings River), and SR 145 (North Fork).

DWR is currently assisting in the planning and coordination of major implementation actions of the 2012 Central Valley Flood Protection Plan (CVFPP) through the Central Valley Flood Management Planning (CVFMP) Program, which will identify improvements to the project flood control facilities and 1,200 miles of designated floodways collectively called the State Plan for Flood Control. The program will also identify flood hazard areas in urban or urbanizing areas of the Central Valley and recommend levees or other means for protecting these areas. The California Public Resources Code 5096.805 identifies an urban area as any contiguous area in which more than 10,000 residents are protected by project levees. The mandate is to provide flood protection by the year 2025 for urban and urbanizing areas from a 200-year flood event. DWR is currently defining and mapping 200-year flood hazard areas.

Non-project flood control facilities include levees and related facilities constructed by local agencies along rivers, creeks, and streams in the Central Valley. Many of these facilities are operated and maintained similar to project facilities, and some connect to project facilities. By definition, they are not part of the State Plan for Flood Control; however, the non-project levees affect the performance of the State Plan for Flood Control as part of the flood protection system.

Designated floodways preserve flood capacity under the primary nonstructural flood management program in California. The program started in 1968 to control encroachments and preserve the flow regimes of floodways to protect public improvements, lives, and land-use values (California Water Code Section 8609). Designated floodways are defined as follows: (1) the channel of the stream and that portion of the adjoining floodplain reasonably required to provide for the passage of a design flood, as indicated by floodway encroachment lines on an adopted map, or (2) the floodway between existing levees, as adopted by CVFPB or the California legislature. Floodways are designated by CVFPB and serve a critical function in protecting life and property from flood risks. Statewide, the designated floodway system includes more than 60 designated floodways and more than 1,300 miles of stream.

This section discusses each of the floodplains crossed by the FB Section, the proposed crossing types, and the potential floodplain impacts and mitigation measures for the crossings.

2.1 Floodplains Crossed

This section describes existing conditions of each floodplain crossed by the HST. Table 2.1-1 lists the length (in miles) for each floodplain crossing associated with each HST alignment. Table 2.1-2 notes the station numbers at which each alignment enters and leaves a FEMA 100-year floodplain. The edge of the WSE shown on the drawings does not always correspond exactly to the floodplain boundaries defined by FEMA, since the exact extent of the WSE is dependent on variations in the topography along the alignment. For purposes of design, the extent and height of the WSE were determined by a variety of methods, depending on how much data were available at each location. The method used for each floodplain is also noted in Table 2.1-2.

Table 2.1-1
Length of Floodplains Crossed by HST Alignment

Alignment	Approximate Length (mi) Crossed by Proposed HST Alignments											
	Church Avenue	Central Canal	Kings River Complex	Kings River	Cross Creek	Tule River	Deer Creek	County Line Creeks	Poso Creek	Shafter	Weidenbach Street	Kern River
F1	0.62	0.03	-	-	-	-	-	-	-	-	-	-
H	-	-	2.59	-	-	-	-	-	-	-	-	-
HW	-	-	-	3.12	-	-	-	-	-	-	-	-
HW2	-	-	-	3.12	-	-	-	-	-	-	-	-
K1	-	-	-	-	3.14	-	-	-	-	-	-	-
K2	-	-	-	-	3.89	-	-	-	-	-	-	-
K3	-	-	-	-	3.91	-	-	-	-	-	-	-
K4	-	-	-	-	3.28	-	-	-	-	-	-	-
K5	-	-	-	-	3.92	-	-	-	-	-	-	-
K6	-	-	-	-	3.92	-	-	-	-	-	-	-
C1	-	-	-	-	0.81	2.41	-	-	-	-	-	-
C2	-	-	-	-	0.79	3.48	-	-	-	-	-	-
C3	-	-	-	-	0.81	2.54	-	-	-	-	-	-
P	-	-	-	-	-	-	0.66	-	-	-	-	-
A1	-	-	-	-	-	-	3.18	-	0.02	-	-	-
A2	-	-	-	-	-	-	5.34	0.40	-	-	-	-
L1	-	-	-	-	-	-	-	-	2.05	-	-	-
L2	-	-	-	-	-	-	-	-	2.02	-	-	-
L3	-	-	-	-	-	-	-	-	1.73	-	-	-
L4	-	-	-	-	-	-	-	-	1.73	-	-	-
WS1	-	-	-	-	-	-	-	-	-	0.31	1.83	-
WS2	-	-	-	-	-	-	-	-	-	-	1.43	-
B1	-	-	-	-	-	-	-	-	-	-	-	1.52
B2	-	-	-	-	-	-	-	-	-	-	-	1.61
B3	-	-	-	-	-	-	-	-	-	-	-	1.61

Table 2.1-2
FEMA 100-year Floodplain Limits

Alignment	Floodplain Source	Limits of FEMA 100yr floodplain (station numbers)[1]	Limit of CVFPB designated floodway	Method for determination of WSE
F1	Church Avenue	373+30 to 406+10		empirical analysis
F1	North Central Canal (add to HHD)	492+50 to 493+40		assume WSE is at top of bank
F1	Central Canal	524+00 to 525+80		HEC-RAS model
H	Kings River	1486+40 to 1623+50		HEC-RAS model and empirical analysis
HW	Kings River	1336+50 to 1501+20		HEC-RAS model and empirical analysis
HW2	Kings River	1336+50 to 1501+20		HEC-RAS model and empirical analysis
K1	Cross Creek	2375+60 to beyond end of alignment	2405+00 to 2498+80	HEC-RAS model and empirical analysis
K2	Cross Creek	2380+20 to 2585+40, 2587+20 to 2589+00	2403+80 to 2550+50	HEC-RAS model and empirical analysis
K3	Cross Creek	2414+50 to 2617+70, 2619+40 to 2621+20	2448+80 to 2583+80	HEC-RAS model and empirical analysis
K4	Cross Creek	2412+40 to beyond end of alignment	2448+70 to 2533+30	HEC-RAS model and empirical analysis
K5	Cross Creek	2375+00 to beyond end of alignment	2404+70 to 2498+20	HEC-RAS model and empirical analysis
K6	Cross Creek	2377+60 to 2582+80, 2584+60 to 2586+30	2400+20 to 2548+90	HEC-RAS model and empirical analysis
C1	Cross Creek	Before start of alignment to 2618+40		empirical analysis
C1	Tule River	2915+20 to 3041+40		HEC-RAS model and empirical analysis
C2	Cross Creek	Before start of alignment to 2611+60		empirical analysis
C2	Tule River	2858+40 to 3041+70		HEC-RAS model and empirical analysis
C3	Tule River	2915+60 to 3041+40		HEC-RAS model and empirical analysis
P		3352+00 to 3432+40		elevation/depth given by FEMA map
A1	Deer Creek	4006+20 to 4007+60,		empirical analysis

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Alignment	Floodplain Source	Limits of FEMA 100yr floodplain (station numbers)[1]	Limit of CVFPB designated floodway	Method for determination of WSE
		4022+00 to 4190+20		
A1	Poso Creek	4713+50 to 4743+70, 4916+60 to beyond end of alignment		first section: empirical analysis end of alignment: HEC-RAS model
A2	Deer Creek	4007+30 to 4009+30, 4023+60 to 4304+40		empirical analysis
A2	North County Line Creek	4449+10 to 4467+30		empirical analysis
A2	South County Line Creek	4528+50 to 4532+20		empirical analysis
A2	Poso Creek	Alignment does not enter official FEMA floodplain. However, HEC-RAS modeling results indicate that floodwater will extend to the alignment. The approximate flood limit is shown on the plans.		HEC-RAS model
L1	Poso Creek	Before start of alignment to 5261+20		HEC-RAS model and empirical analysis
L2	Poso Creek	Before start of alignment to 5261+70, 5294+20 to 5379+90		HEC-RAS model and empirical analysis
L3	Poso Creek	5170+30 to 5262+20		HEC-RAS model and empirical analysis
L4	Poso Creek	5170+30 to 5262+20, 5329+80 to 5379+60		HEC-RAS model and empirical analysis
WS1	Shafter	5976+80 to 5995+80, 5997+00 to 6031+40		elevation/depth given by FEMA map
WS1	Weidenbach Street	6166+90 to 6263+20		empirical analysis
WS2	Weidenbach Street	6146+00 to 6220+60		empirical analysis
B1	Kern River	7118+06 to 7102+27, 7094+07 to 7050+29, 7046+25 to 7021+90, 7017+81 to 7016+91		HEC-RAS model and empirical analysis
B2	Kern River	7112+85 to 7088+73, 7061+70 to 7048+54, 7043+76 to 7021+52		HEC-RAS model and empirical analysis

Alignment	Floodplain Source	Limits of FEMA 100yr floodplain (station numbers)[1]	Limit of CVFPB designated floodway	Method for determination of WSE
B3	Kern River	7112+85 to 7088+73, 7061+70 to 7048+54, 7043+76 to 7021+52		HEC-RAS model and empirical analysis

[1] Due to the recognized complex nature of flows within these floodplains, additional analysis was carried out to better define actual floodplain extents and floodplain depth. On the plans, the FEMA floodplain boundaries are identified as "LIMIT OF 100YR FEMA FLOODPLAIN." The limits of the estimated 100-year flood shown on the rail alignment plans are approximate, based on preliminary hydraulic modeling and empirical analysis, and identified with the name of the water body associated with the flooding, e.g., "Limit of Poso Creek Floodplain."

Due to the width of the right-of-way and the angle at which the alignment enters the floodplain, the point at which the HST alignment encounters the FEMA floodplain boundary may vary by several hundred feet across the right-of-way.

2.1.1 City of Fresno

The HST is proposed to cross the Church Avenue and Central Canal floodplains (Zones AH) downstream (west) of the existing Union Pacific Railroad and BNSF railways within the City of Fresno. The HST crossing at Church Avenue will be slightly below-grade, in a shallow trench with walls that extend above the floodplain; whereas, Central Canal will be crossed at grade or by an elevated structure.

Central Canal is 30 feet wide, with a 170-foot-wide floodplain (Zone AE). Central Canal is essentially a large irrigation/drainage ditch flowing east to west through Fresno. The base flood flow is mostly contained in the channel with possibly some minor flooding to the immediate sides of the channels. There are no levees along Central Canal. Canals within the city are owned and operated by the Fresno Irrigation District in cooperation with the City of Fresno and FMFCD.

The shallow floodplain near Church Avenue appears to be a local depression that fills with surface runoff during extreme events due to inadequate local drainage systems (Figure 2.1-1). No channels are related to this floodplain, and therefore there is no concentrated through flow. Meetings with the FMFCD have found that upstream localized improvements have been made to improve the flooding conditions in the vicinity of Church Avenue. Updated floodplain mapping has not yet been completed for the area. Retaining walls will prevent floodwater from entering the trench, and siphons perpendicular to the rail alignment will balance floodwaters.

2.1.2 Kings River Complex (Cole Slough, Dutch John Cut, Kings River)

2.1.2.1 Hanford Alignment

The H Alignment of the HST is proposed to cross Cole Slough, Dutch John Cut, and the Kings River (collectively referred to as the Kings River Complex) on an 11,684-foot-long elevated viaduct, which covers the majority portion of the 13,700-foot-wide FEMA Zone A floodplain (Figure 2.1-2).

Cole Slough, Dutch John Cut, and the Kings River are meandering channels contained between vegetated banks at the border of Fresno and Kings Counties. The H Alignment of the HST crosses the Kings River Complex approximately 3.0 miles east of the town of Laton. At the proposed crossings, the channel width of Cole Slough, outside of levee to outside of levee, is approximately 250 feet, while the main channel is approximately 150 feet wide. The Dutch John Cut channel width at the crossing point, landside toe of levee to landside toe of levee, is approximately 600 feet, and the main channel is approximately 100 feet wide. At the crossing of the Kings River, bank-to-bank width is approximately 500 feet, and the main channel is approximately 100 feet wide. The alignment's crossings of the main channel of Cole Slough, Dutch John Cut, and Kings River will occur at an approximate 70 to 80 degree angle.

The two levees on Cole Slough and the northern levee on Dutch John Cut are Federal/State Project levees maintained by the KRCD under USACE agreement. There are no levees on the Kings River. There are agricultural and residential structures within the floodplain in the vicinity of the crossing.

2.1.2.2 Hanford West Bypass Alignment – HW

The HW Alignment of the HST is proposed to cross Kings River and portion of the 16,500-foot-wide floodplain (Zone A) on an 8,520-foot-long elevated viaduct and embankment with small structures within the remaining floodplain for wildlife and floodwater passage (Figure 2.1-3 and Figure 2.1-4).

Kings River is a meandering channel contained between vegetated banks at the border of Fresno and Kings Counties. The HW Alignment of the HST crosses the Kings River approximately 0.6 miles west of the town of Laton. At the proposed crossings, the channel width of Kings River, outside of levee to outside of levee, is approximately 1,625 feet, while the main channel is approximately 400 feet wide. The crossing of the main channel of Kings River will occur at an approximate 80 degree angle.

The two levees on Kings River are federal/state project levees maintained by the KRCD under USACE agreement. There are agricultural and residential structures within the floodplain in the vicinity of the crossing.

2.1.2.3 Hanford West Bypass Alignment – HW2

The HW2 Alignment of the HST is proposed to cross Kings River and portion of the 16,500-foot-wide floodplain (Zone A) on an 8,520-foot-long elevated viaduct and embankment, with small structures within the floodplain for wildlife and floodwater passage (Figure 2.1-3 and Figure 2.1-4). After crossing the floodplain, the HW2 alignment runs gradually below grade and underpasses SR 198 and San Joaquin Valley Railroad.

Kings River is a meandering channel contained between vegetated banks at the border of Fresno and Kings Counties. The HW Alignment of the HST crosses the Kings River approximately 0.6 miles west of the town of Laton. At the proposed crossings, the channel width of Kings River, outside of levee to outside of levee, is approximately 1,625 feet, while the main channel is approximately 400 feet wide. The crossings of the main channel of Kings River will occur at an approximate 80 degree angle.

The two levees on Kings River are federal/state project levees maintained by the KRCD under USACE agreement. There are agricultural and residential structures within the floodplain in the vicinity of the crossing.

2.1.3 Cross Creek

Alignments K1, K2, K3, K4, K5, and K6 intersect Cross Creek approximately 5 miles north of the City of Corcoran at the vicinity of the existing BNSF rail line. The Cross Creek channel is gently winding and is contained by tall levees. The trapezoidal channel is approximately 100 feet wide at the base. The crossings would occur at near 45 degree angles (Figure 2.1-5). The Cross Creek levees are maintained by the Cross Creek Flood Control District. However, these levees are not certified for urban protection and, therefore, are not considered by FEMA as providing urban-level flood protection and are assumed to fail in a flood event. Therefore, the FEMA FIS and DFIRM floodplain map for Cross Creek do not take the levees into consideration. The special flood hazard zones designated by FEMA include Zone AE and Zone A. A floodway at Cross Creek is delineated on the DFIRM. There are several smaller openings in the BNSF embankment to the north and south that appear to pass flood flows. There are agricultural and residential structures within the floodplain in the vicinity of the crossing. Additionally the CVFPB has delineated a floodway for Cross Creek, which is wider than the FEMA floodway at the six HST alignment crossings. All six HST alignments are proposed to cross the CVFPB floodway on viaduct.

2.1.4 Tule River

Alignments C1, C2, and C3 cross the Tule River downstream of the existing BNSF rail line and State Route (SR) 43. At the proposed crossings, the channel width is less than 180 feet. The crossing would occur at an approximate 90 degree angle to the floodplain (Zone A) for all alignments (Figure 2.1-6). This reach of Tule River is not leveed. Along the southern side of the channel, upstream of SR 43, is a raised embankment containing an irrigation canal. The irrigation canal passes under SR 43 and BNSF via a culvert. The DFIRM mapping implies that some floodwater may pass through this culvert and then flow back into the Tule River channel on the west side of BNSF. There are also several smaller openings in the BNSF embankment north of the main channel that appear to pass flood flows.

2.1.5 Deer Creek

Deer Creek is sparsely vegetated and has been channelized through the reach crossed by Alignments A1 and A2 in Tulare County. Alignment P does not cross Deer Creek but does fall within extensions of the Deer Creek floodplain. At the proposed A1 and A2 crossings, downstream (west) of the existing BNSF rail line, the approximately 40-foot-wide channel has short berms on both sides. The floodplain (Zones A and AO) extends along the BNSF railroad up to 13 miles, due to the flat terrain, on both the north and south sides of Deer Creek. Downstream of the BNSF railroad, there are wide gaps between the floodplain within the Deer Creek channel and the remaining floodplain (Figures 2.1-7, 2.1-8, and 2.1-9). Floodwater appears to back up behind the BNSF embankment and pass through culverts south of the main channel. The floodplain also spreads far to the north immediately adjacent to BNSF, crossing back and forth at low points. On Alignments A1 and A2, the crossing would occur at an approximate 60 degree angle. No residential or agricultural developments are evident on this reach of Deer Creek. However, there is a diversion dam approximately 700 feet downstream of SR 43.

2.1.6 County Line Creeks

On the Tulare/Kern County line is a broad floodplain (Zone A) encompassing two small, barely defined, winding channels. Alignment A1 passes to the west of County Line Creeks and does not cross the floodplain. Alignment A2 crosses the commingled floodplains of North and South County Line Creek. The floodplain area crossed is approximately 0.5 miles wide (Figure 2.1-10). The crossing of the channels would occur at an approximate 30 degree angle, downstream of the existing BNSF rail line. BNSF crosses the channels on small structures. The angle of floodplain incidence is approximately 60 degrees. Downstream of BNSF, the channel is ill-defined and the floodplain dissipates quickly. Most of the floodplain is contained by the BNSF embankment to the east of Alignment A2. There are no levees and no residential or agricultural structures near the proposed alignment crossing.

2.1.7 Poso Creek

Alignments L1 through L4 in Kern County cross Poso Creek just north of Wasco. The low-flow channel downstream of the existing BNSF rail line where the alignments cross is approximately 200 feet wide, gently meandering, and vegetated. According to FEMA data, the floodplain (Zone A) is up to 1.7 miles wide downstream of the existing BNSF rail line and appears to be much wider upstream of SR 43, as the highway likely causes a channel constriction (Figure 2.1-11 and Figure 2.1-12). On all alignments, the crossing of the main channel would occur at an approximate 30 degree angle. Scattered agricultural and residential structures are present both upstream and downstream of the proposed alignment crossing.

2.1.8 City of Shafter

There are two small unnamed floodplains delineated in the DFIRM mapping in the vicinity of the WS Alignments. One (Zones AH and AO) is in downtown Shafter just east of the existing BNSF tracks, and the other (Zone A) is approximately 4.4 miles southeast of Shafter near Weidenbach Street centered on Santa Fe Way and the existing BNSF tracks (see Figure 2.1-13 and Figure 2.1-14). These floodplains are similar to the Church Avenue floodplain in that they appear to be shallow local depressions that fill with

surface runoff during extreme events due to inadequate local drainage. No channels are related to these floodplains, so there is no concentrated flow into or out of the area, only surface flow that ponds and then infiltrates or evaporates.

2.1.9 Kern River

The Kern River flows through Kern County and the City of Bakersfield. It is crossed by the proposed B1, B2, and B3 Alignments near Truxtun Avenue (see Figure 2.1-15). In recent years, the City of Bakersfield has become interested in retaining water in the river channel all year round for recreation and recharging the water tables from which the City draws its drinking water supply. It is unknown how this change to the existing conditions would impact the floodplain.

Upstream of the proposed alignments, the channel is approximately 700 feet wide. However, the floodplain (Zone AE) may be as wide as 3,000 feet where HST alignments are proposed. On all three alignments, the floodplain crossing would occur on a viaduct at an approximate 30 degree angle downstream of the BNSF crossing structure. The section of track that proposes to parallel the river is located along the edge of the floodplain; the maximum expected hydraulic impact would occur at the 30 degree channel crossing upstream of this location. The skewed crossing of the Kern River by Alignment B1, B2, or B3 will require piers placed in the river. The skewed crossing lengths for Alignment B1, B2, and B3 are both approximately 1,500 linear feet.

The alternative alignments through this reach are constrained by a number of factors, including urban and industrial development, existing and proposed rail and road infrastructure, and the allowable turning radius of the HST.

There is a local (City of Bakersfield) combination flood control levee and recreation trail along the south bank of the Kern River at the proposed HST crossing. Any structural encroachments, modifications, or intrusions to this levee feature will be avoided.

2.1.10 Tulare Lake

Tulare Lake lies just southwest of Corcoran between Cross Creek and Deer Creek near the C, P, and A Alignments. The basin is effectively a closed basin without an outlet, and designated by FEMA as Zone A floodplain. According to a 2007 EPA report (EPA, ECORP 2007), the lake filled to an elevation of 192.5 feet in 1969, which is the highest level since the construction of the current modern network of dams, canals, and irrigation facilities. The lake filled again in 1983, but no record of its maximum elevation is available. Water can flow or be pumped out toward the San Joaquin River to the north during extreme events. All HST facilities will be constructed above 192.5 feet.

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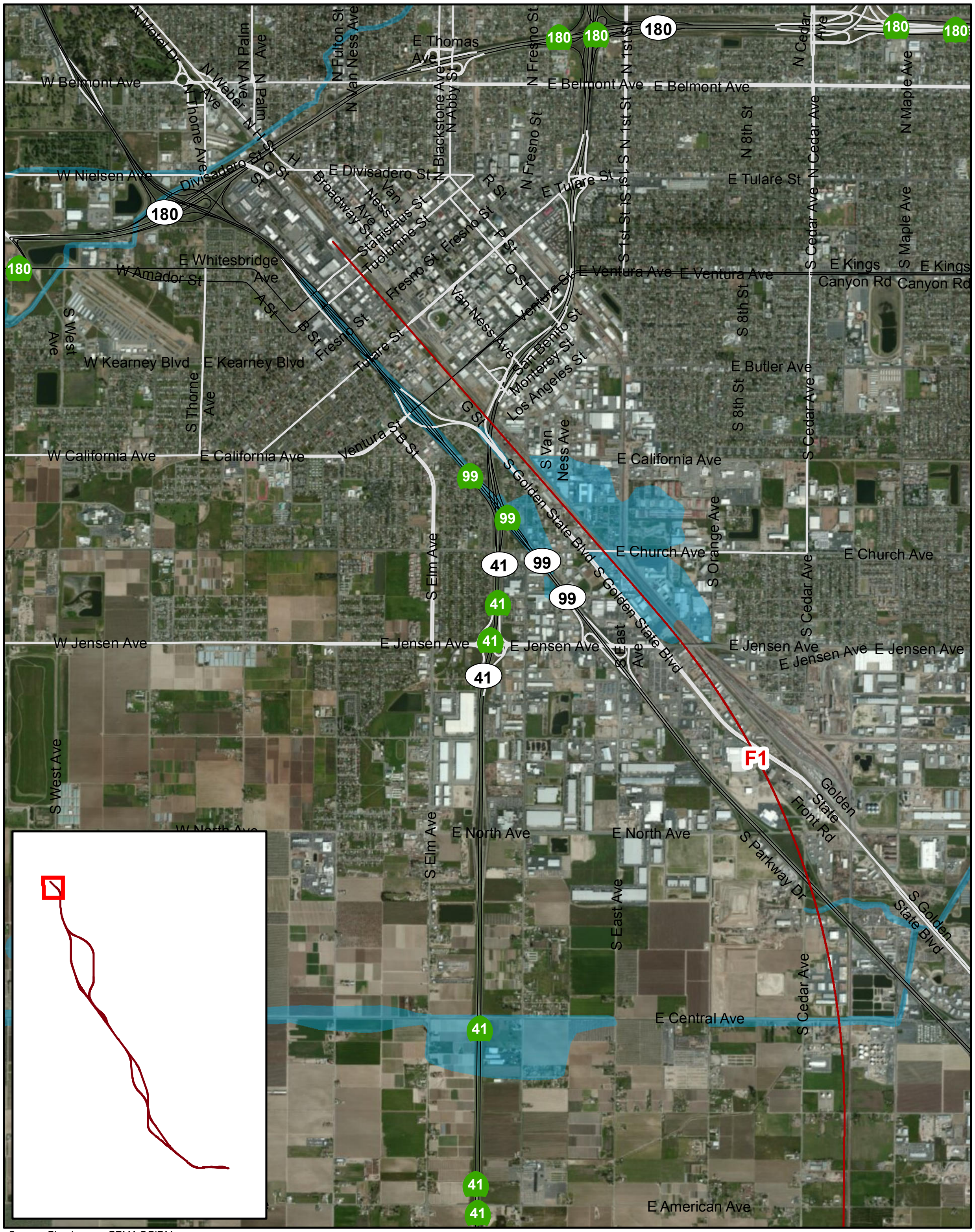


Source: Flood zone - FEMA DFIRM
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

December 2013

N

0 2,000 4,000
Feet

0 500 1,000
Meters

Legend

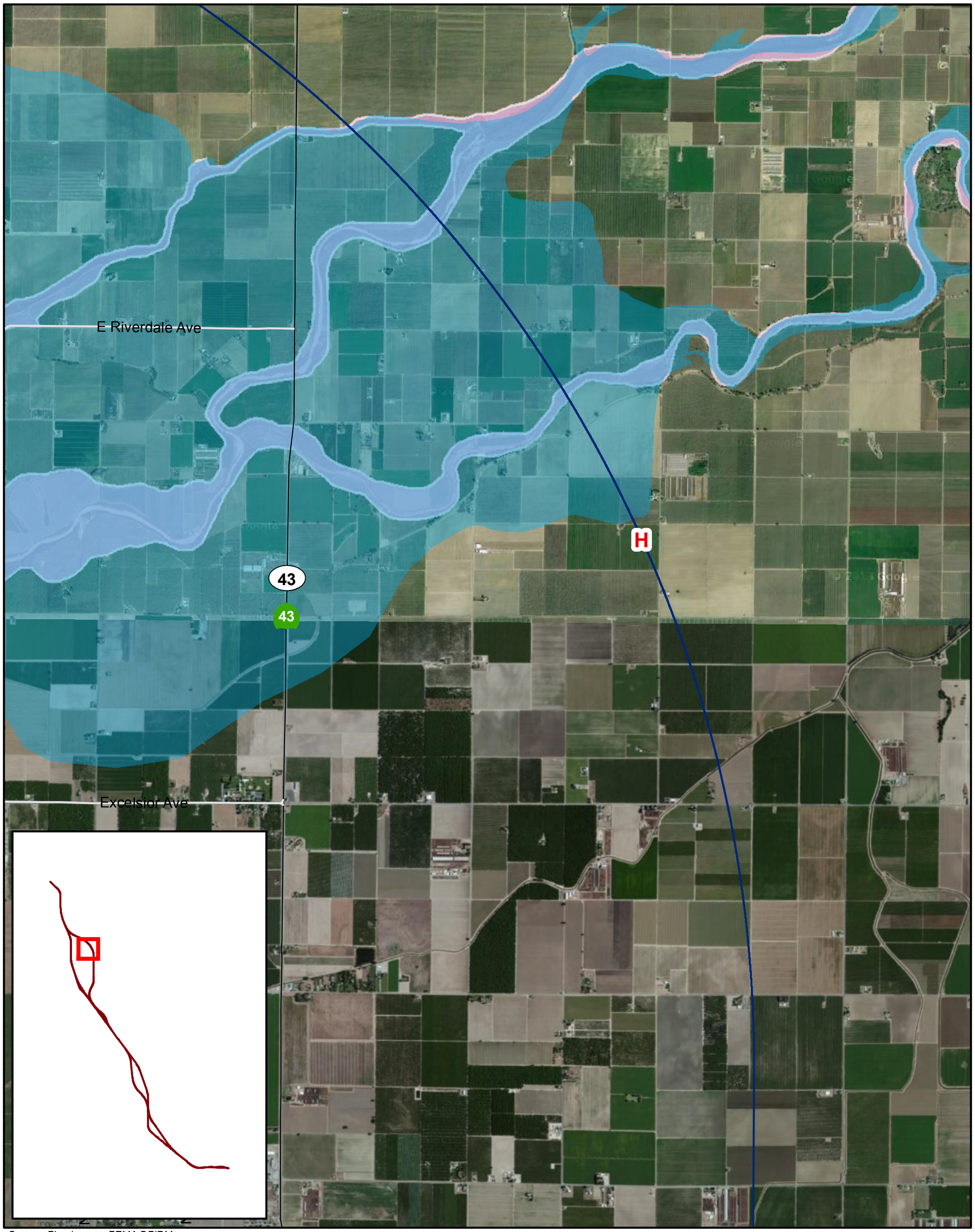
- CVFPB Designated_Floodways
- 100 Year Flood Zones

Alignment Alternatives

- F1
- M
- H, HW, HW2
- K1, K2, K3, K4, K5, K6
- C1, C2, C3
- P
- A1, A2
- L1, L2, L3, L4
- WS1, WS2
- B1, B2, B3

Figure 2.1-1

City of Fresno Floodplains



Source: Flood zone - FEMA DFIRM
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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CVFPB Designated_Floodways

100 Year Flood Zones

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- C1, C2, C3
- P
- A1, A2
- L1, L2, L3, L4
- WS1, WS2
- B1, B2, B3

N

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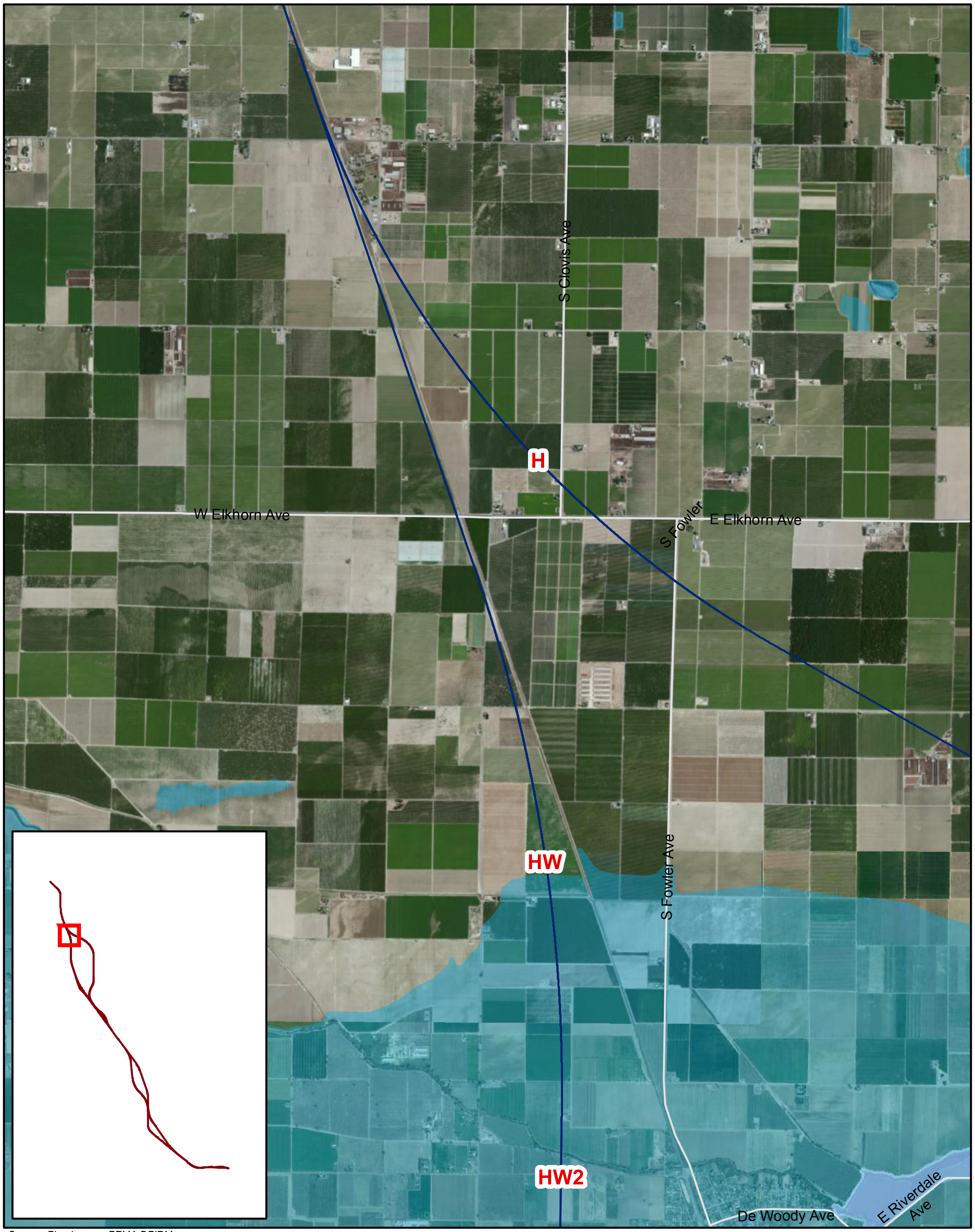
Feet

0 500 1,000
Meters

Figure 2.1-2

Kings River Complex Floodplain



Source: Flood zone - FEMA DFIRM
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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Legend

CVFPB Designated_Floodways

100 Year Flood Zones

Alignment Alternatives

F1
M
H, HW, HW2
K1, K2, K3, K4, K5, K6
C1, C2, C3
P
A1, A2
L1, L2, L3, L4
WS1, WS2
B1, B2, B3

N

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Feet
0 500 1,000
Meters

Figure 2.1-3

Kings River Floodplain

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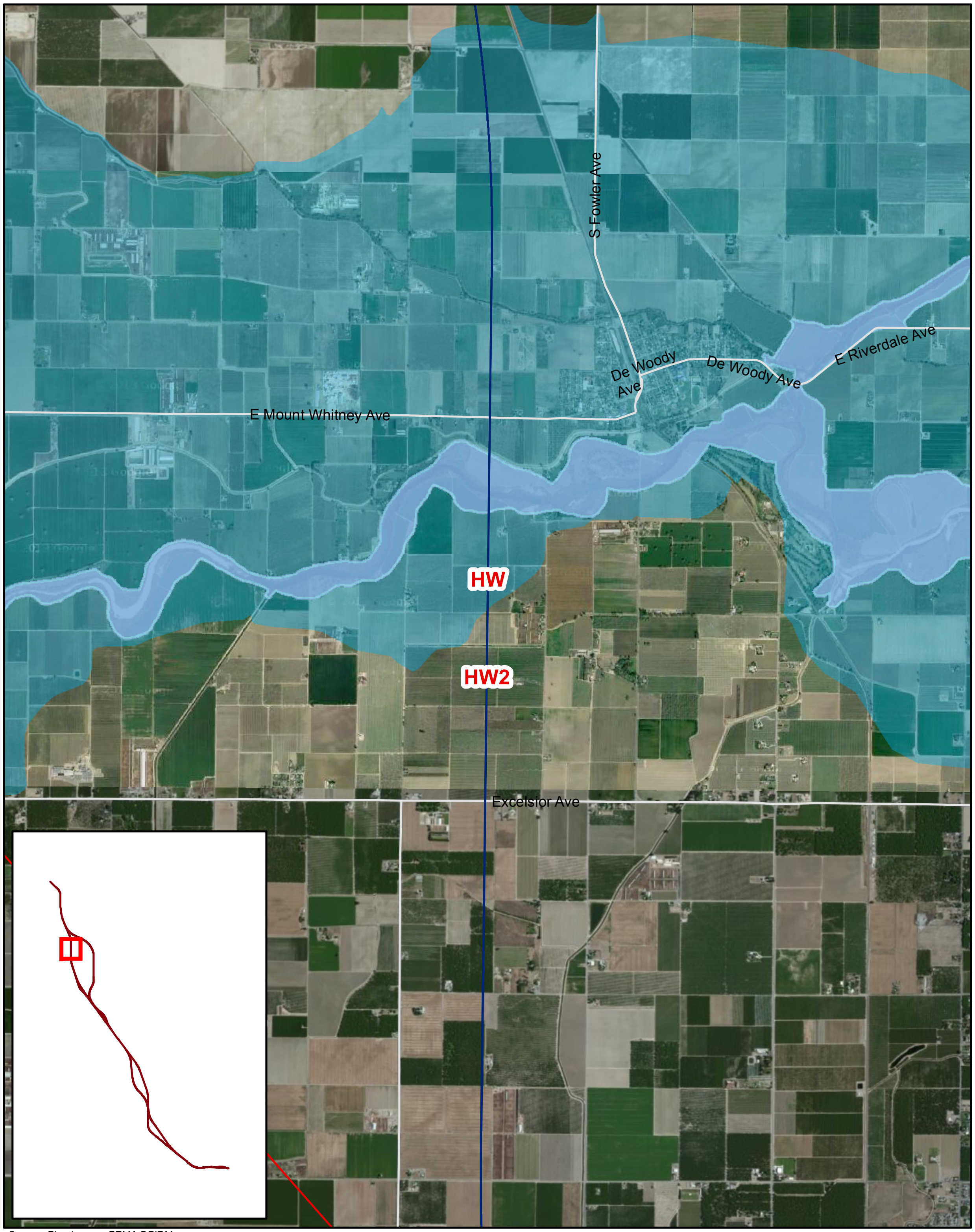

Source: Flood zone - FEMA DFIRM
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

December 2013

Legend

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Alignment Alternatives

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- C1, C2, C3
- P
- A1, A2
- L1, L2, L3, L4
- WS1, WS2
- B1, B2, B3

N

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Feet

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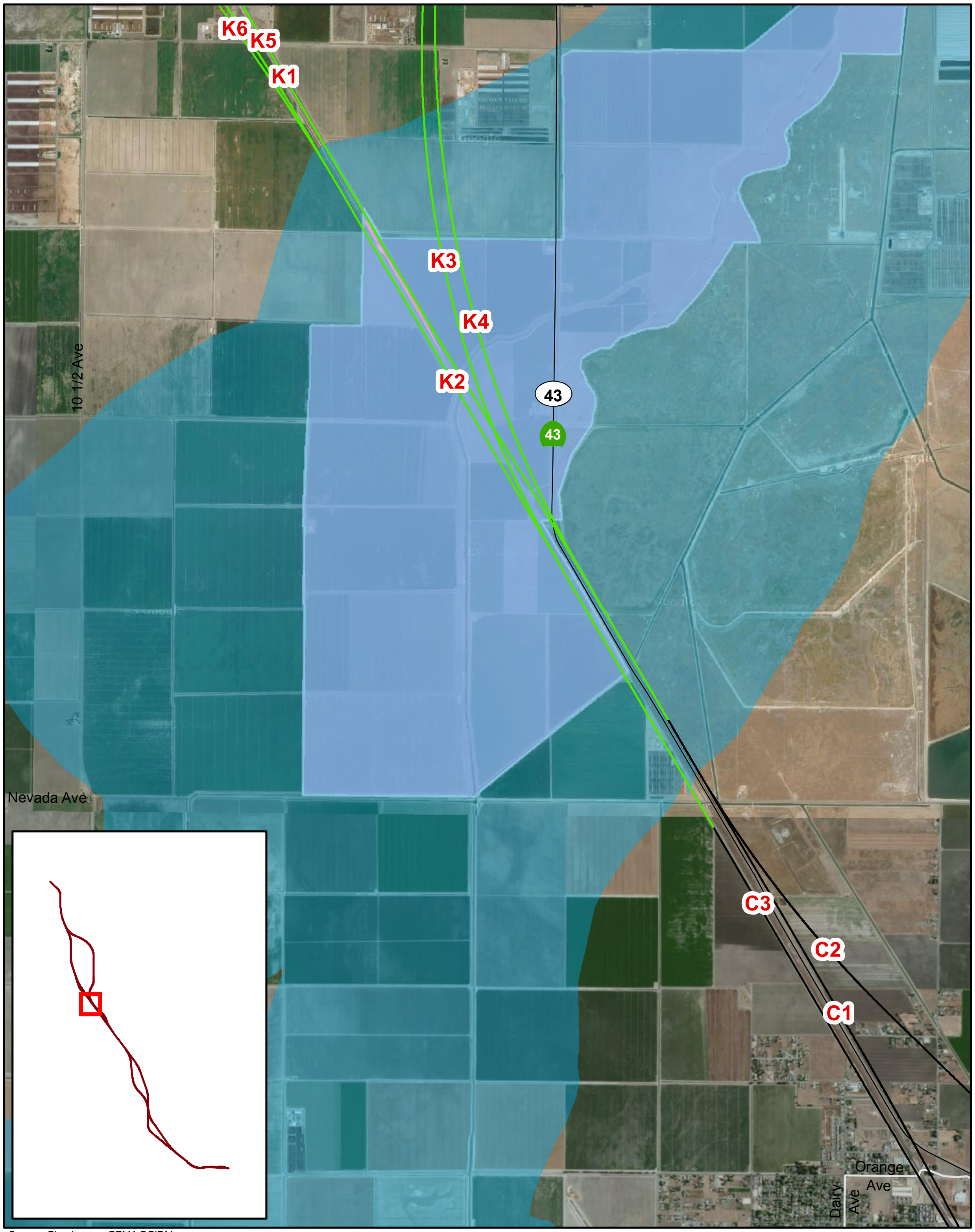
Meters

Figure 2.1-4

Kings River Floodplain



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Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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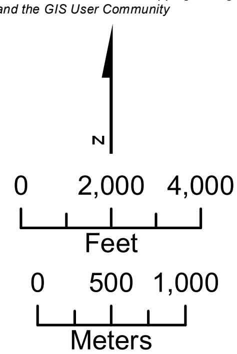


Legend

CVFPB Designated_Floodways

100 Year Flood Zones

Alignment Alternatives

F1

M

H, HW, HW2

K1, K2, K3, K4, K5, K6

C1, C2, C3

P

A1, A2

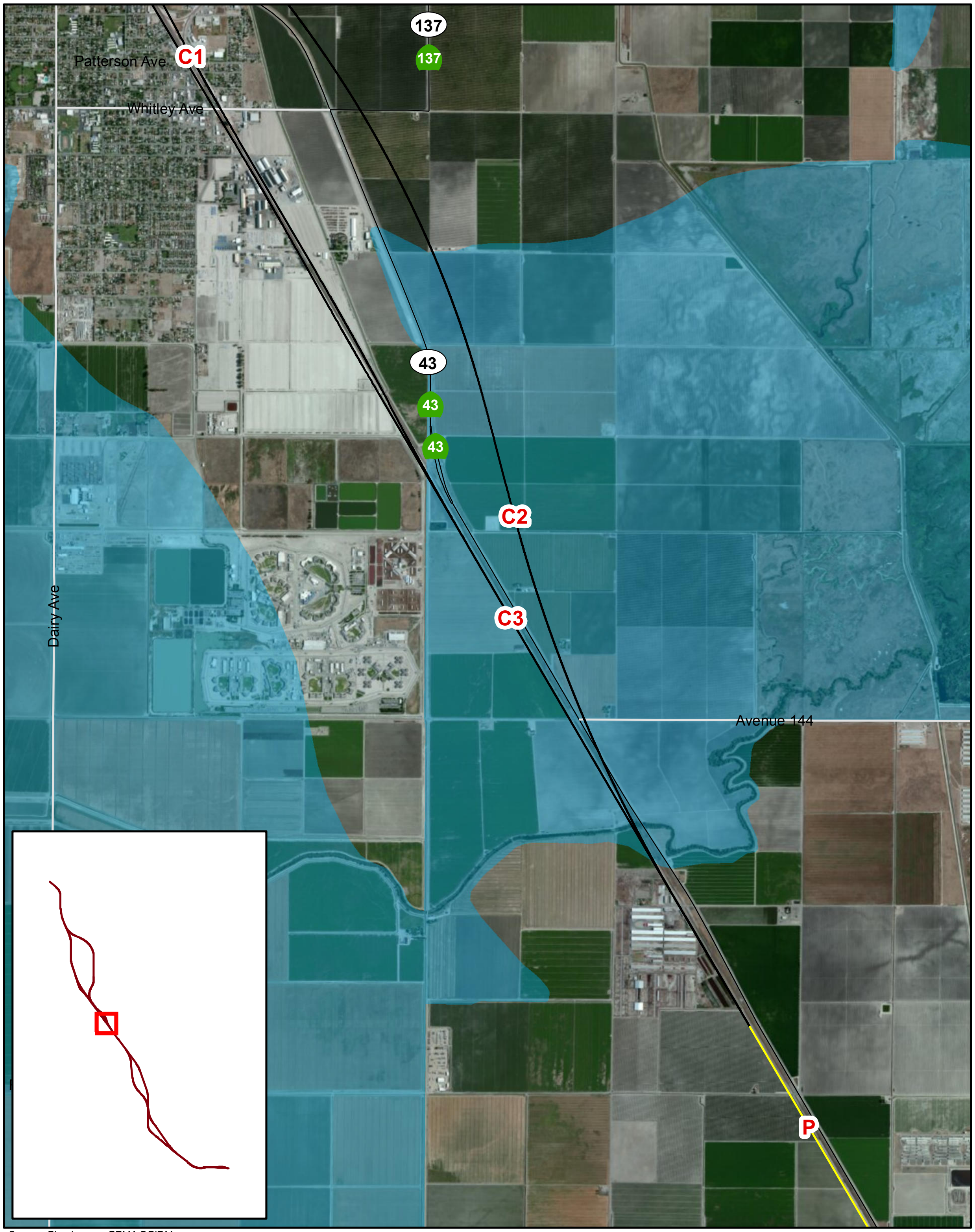
L1, L2, L3, L4

WS1, WS2

B1, B2, B3

Figure 2.1-5

Cross Creek Floodplain



Source: Flood zone - FEMA DFIRM
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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CVFPB Designated_Floodways

100 Year Flood Zones

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- K1, K2, K3, K4, K5, K6
- C1, C2, C3
- P
- A1, A2
- L1, L2, L3, L4
- WS1, WS2
- B1, B2, B3

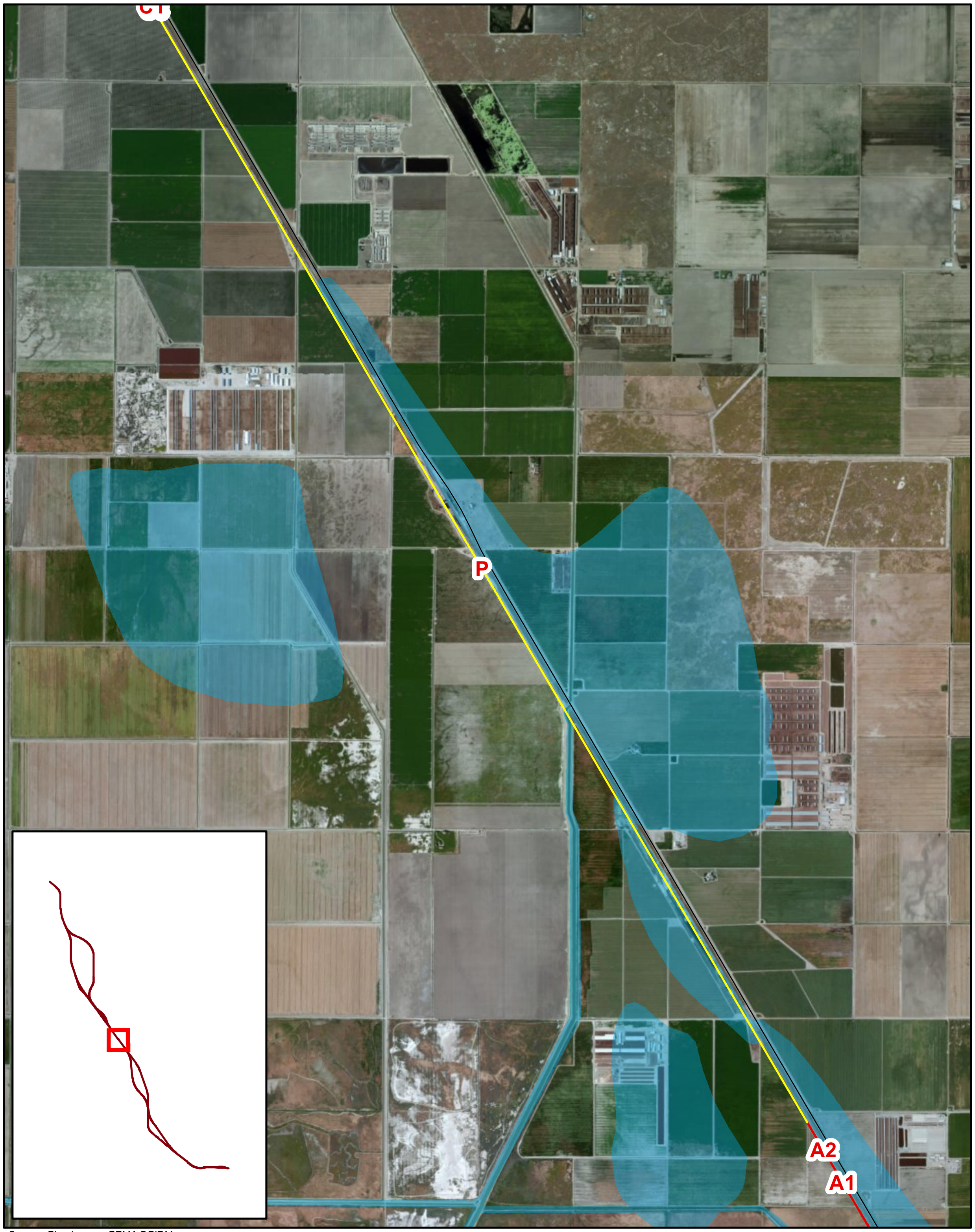
N

0 2,000 4,000
Feet

0 500 1,000
Meters

Figure 2.1-6

Tule River Floodplain



Source: Flood zone - FEMA DFIRM
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

December 2013

Legend

CVFPB Designated_Floodways
100 Year Flood Zones

Alignment Alternatives

F1
M
H, HW, HW2
K1, K2, K3, K4, K5, K6
C1, C2, C3
P
A1, A2
L1, L2, L3, L4
WS1, WS2
B1, B2, B3

N

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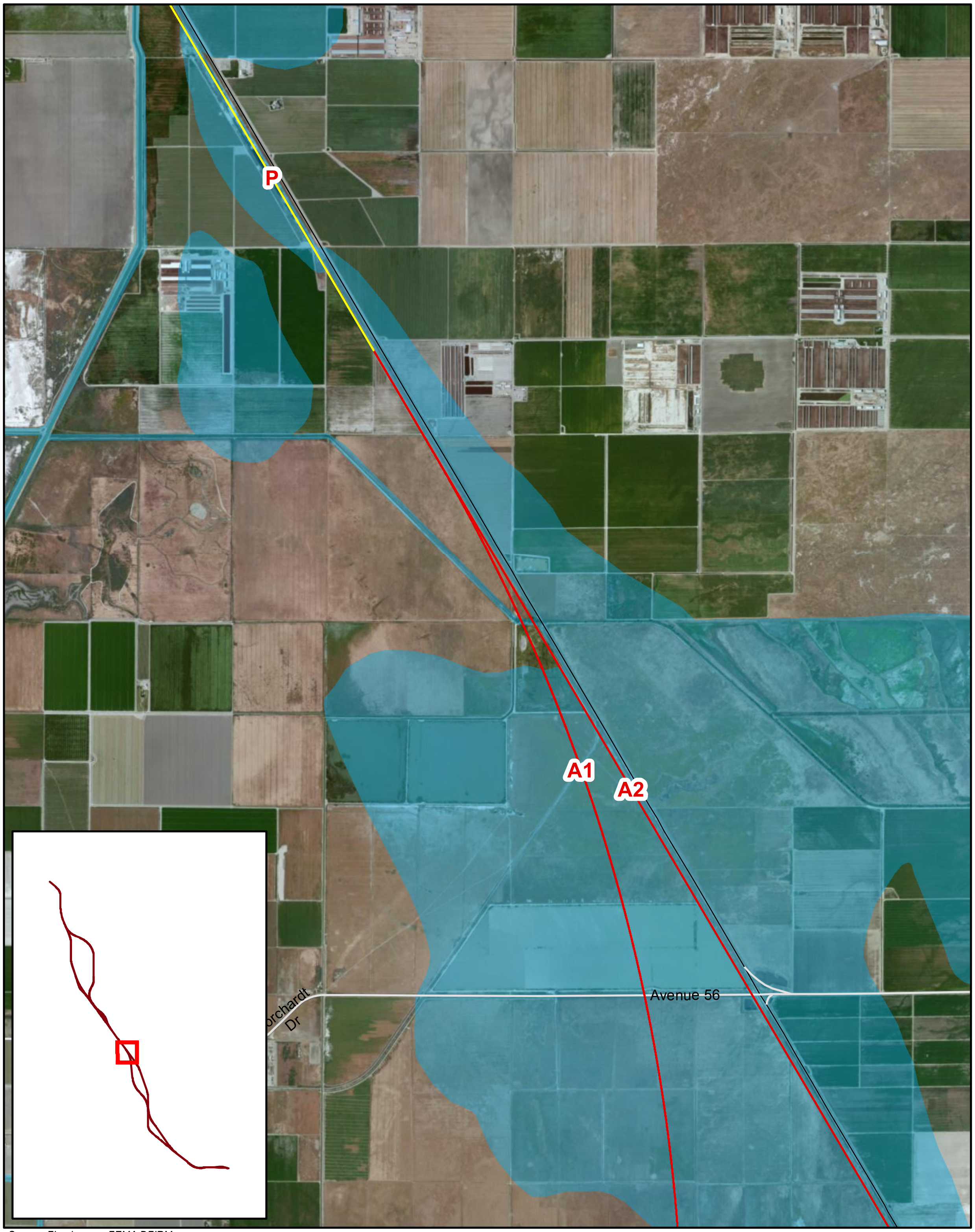
Feet

0 500 1,000
Meters

Figure 2.1-7

North of Deer Creek Floodplain



Source: Flood zone - FEMA DFIRM
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

December 2013

Legend

CVFPB Designated_Floodways
100 Year Flood Zones

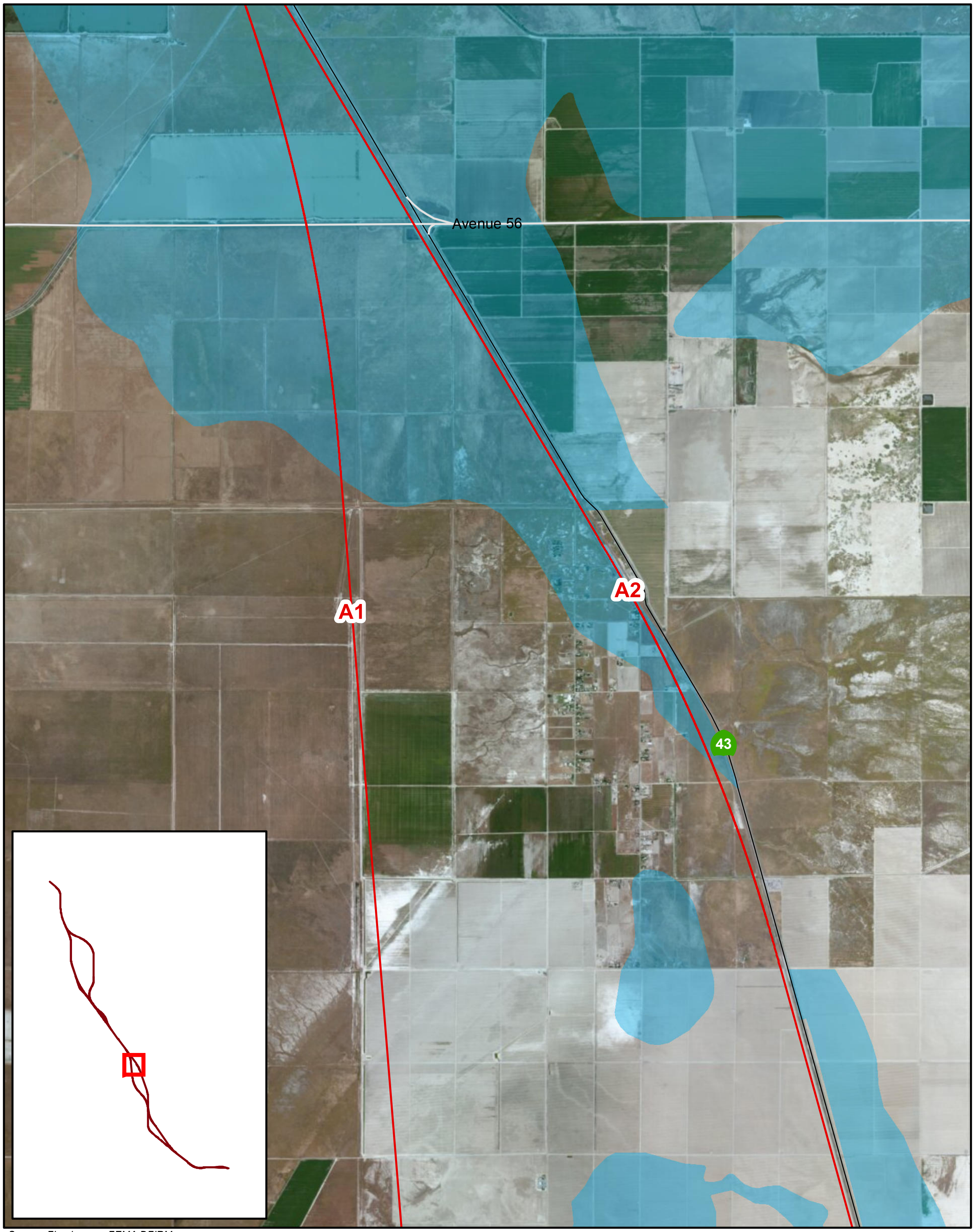
Alignment Alternatives
- F1
- M
- H, HW, HW2
- K1, K2, K3, K4, K5, K6
- C1, C2, C3
- P
- A1, A2
- L1, L2, L3, L4
- WS1, WS2
- B1, B2, B3

N

0 2,000 4,000
Feet

0 500 1,000
Meters

Figure 2.1-8
Deer Creek Floodplain



Source: Flood zone - FEMA DFIRM
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

December 2013

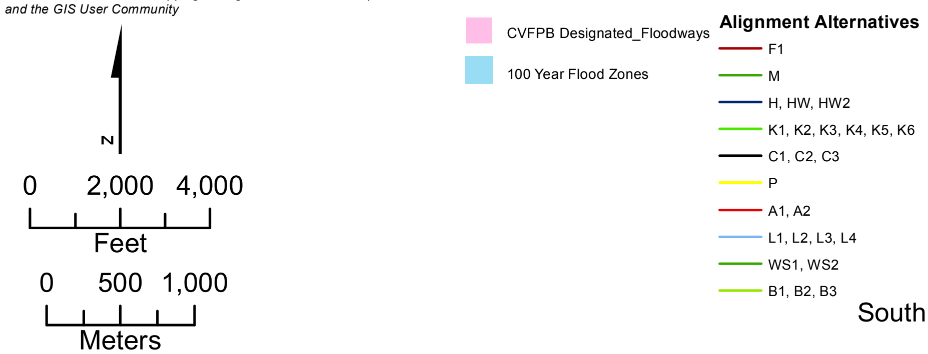


Figure 2.1-9

South of Deer Creek Floodplain

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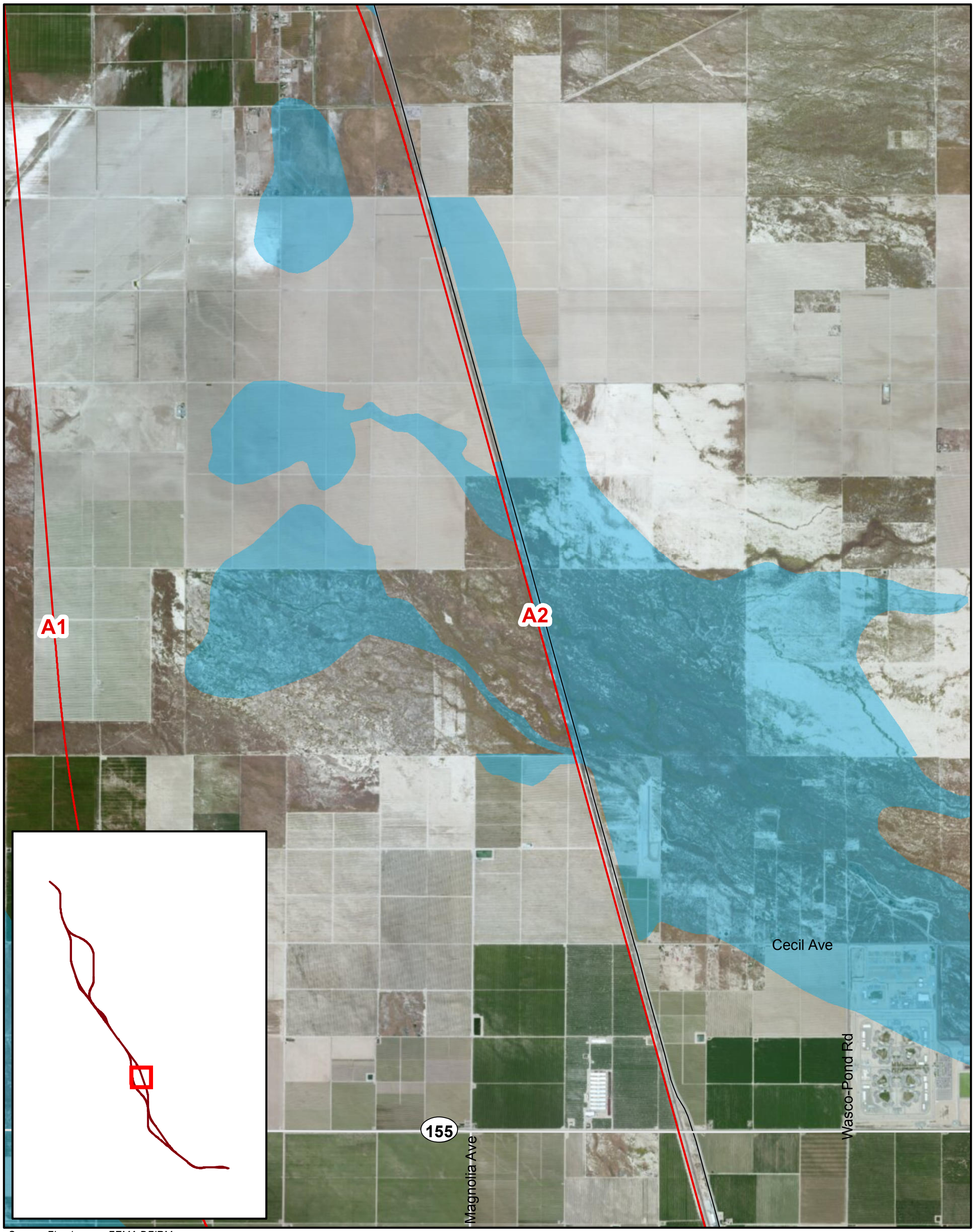


Source: Flood zone - FEMA DFIRM
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

December 2013

Legend

- CVFPB Designated_Floodways
- 100 Year Flood Zones

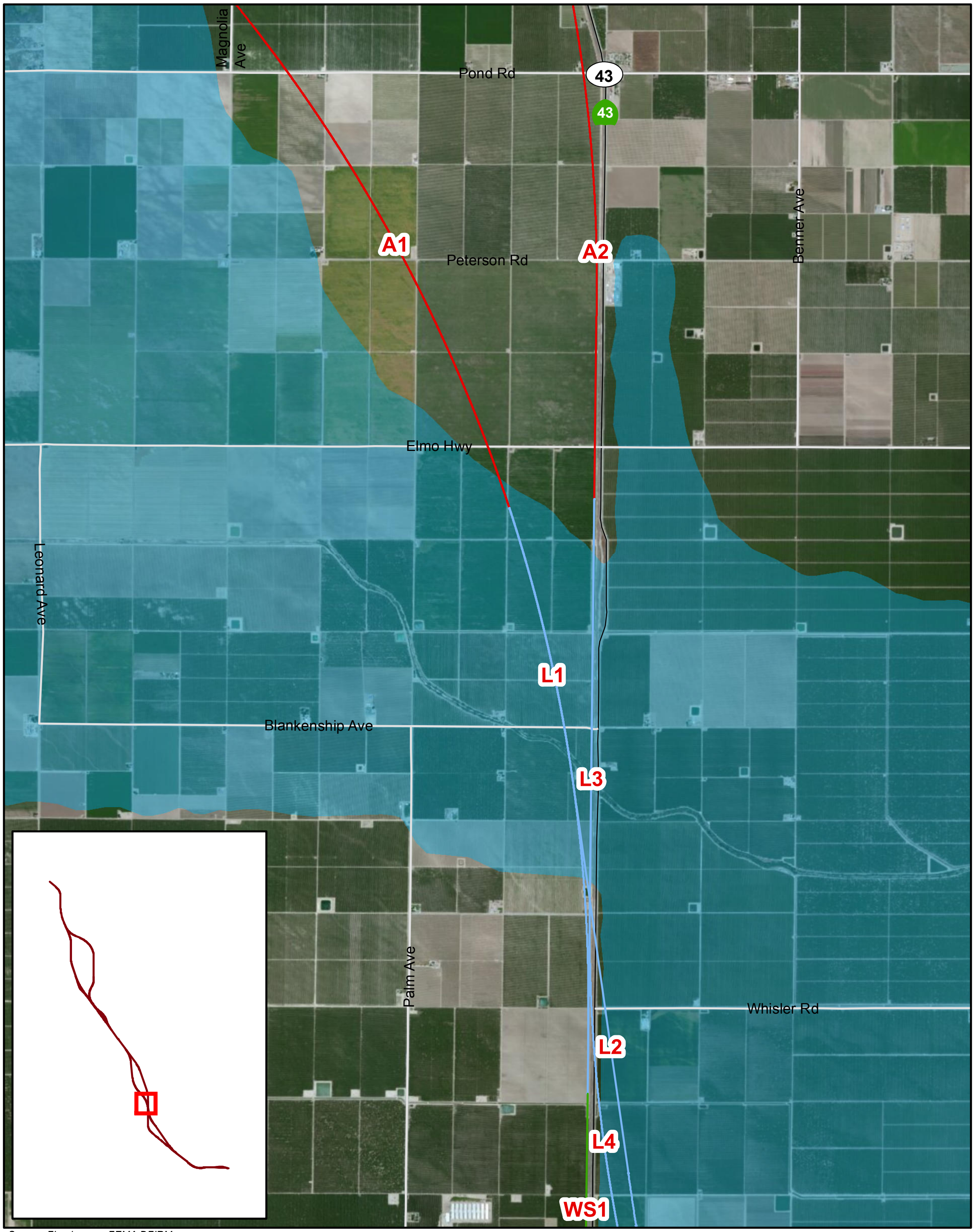
Alignment Alternatives

- F1
- M
- H, HW, HW2
- K1, K2, K3, K4, K5, K6
- C1, C2, C3
- P
- A1, A2
- L1, L2, L3, L4
- WS1, WS2
- B1, B2, B3

N

0 2,000 4,000
Feet
0 500 1,000
Meters

Figure 2.1-10
County Line Creek Floodplain



Source: Flood zone - FEMA DFIRM
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

December 2013

Legend

CVFPB Designated_Floodways

100 Year Flood Zones

Alignment Alternatives

F1
M
H, HW, HW2
K1, K2, K3, K4, K5, K6
C1, C2, C3
P
A1, A2
L1, L2, L3, L4
WS1, WS2
B1, B2, B3

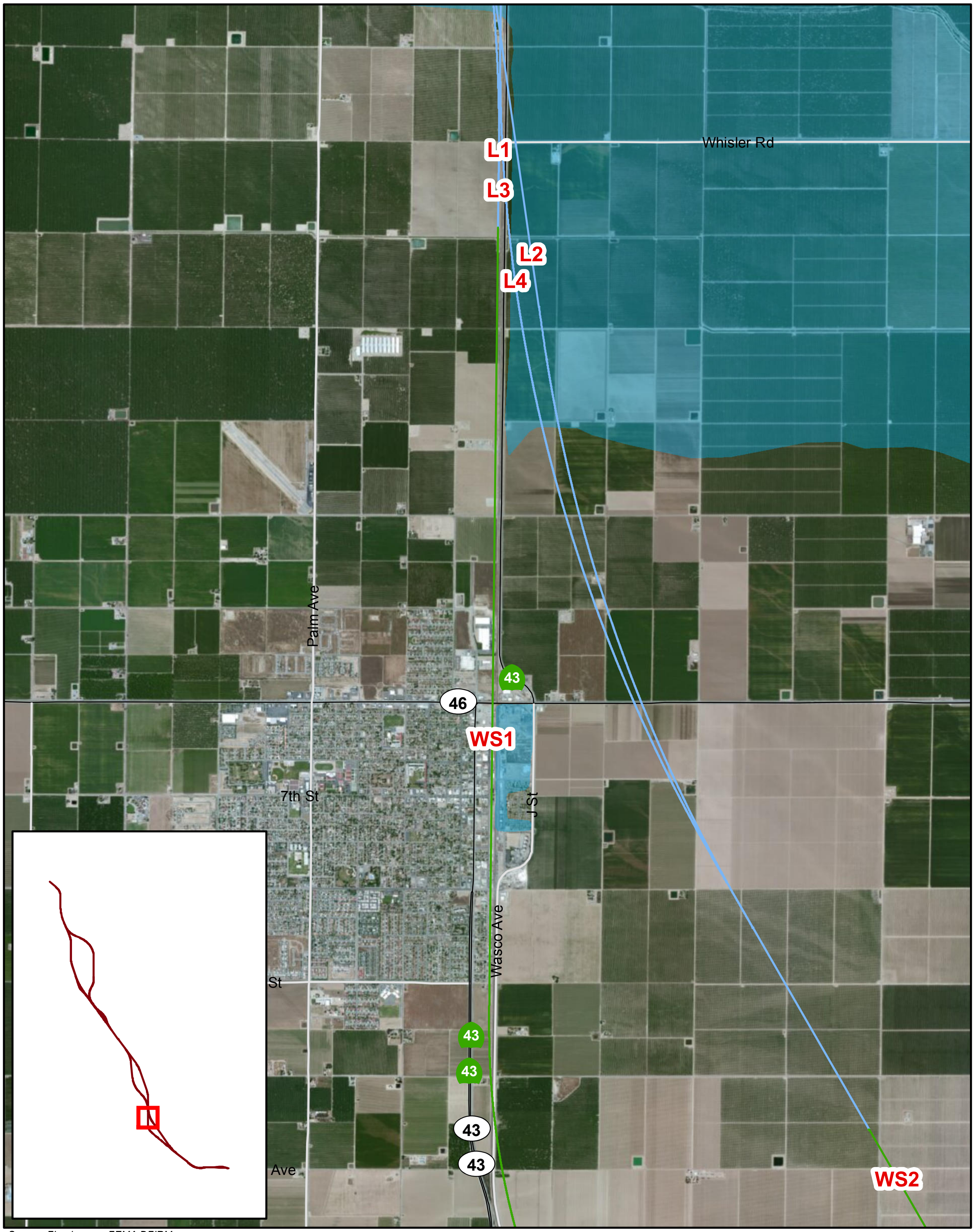
N

0 2,000 4,000
Feet

0 500 1,000
Meters

Figure 2.1-11

Poso Creek Floodplain



Source: Flood zone - FEMA DFIRM
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

December 2013

Legend

- CVFPB Designated_Floodways
- 100 Year Flood Zones

Alignment Alternatives

- F1
- M
- H, HW, HW2
- K1, K2, K3, K4, K5, K6
- C1, C2, C3
- P
- A1, A2
- L1, L2, L3, L4
- WS1, WS2
- B1, B2, B3

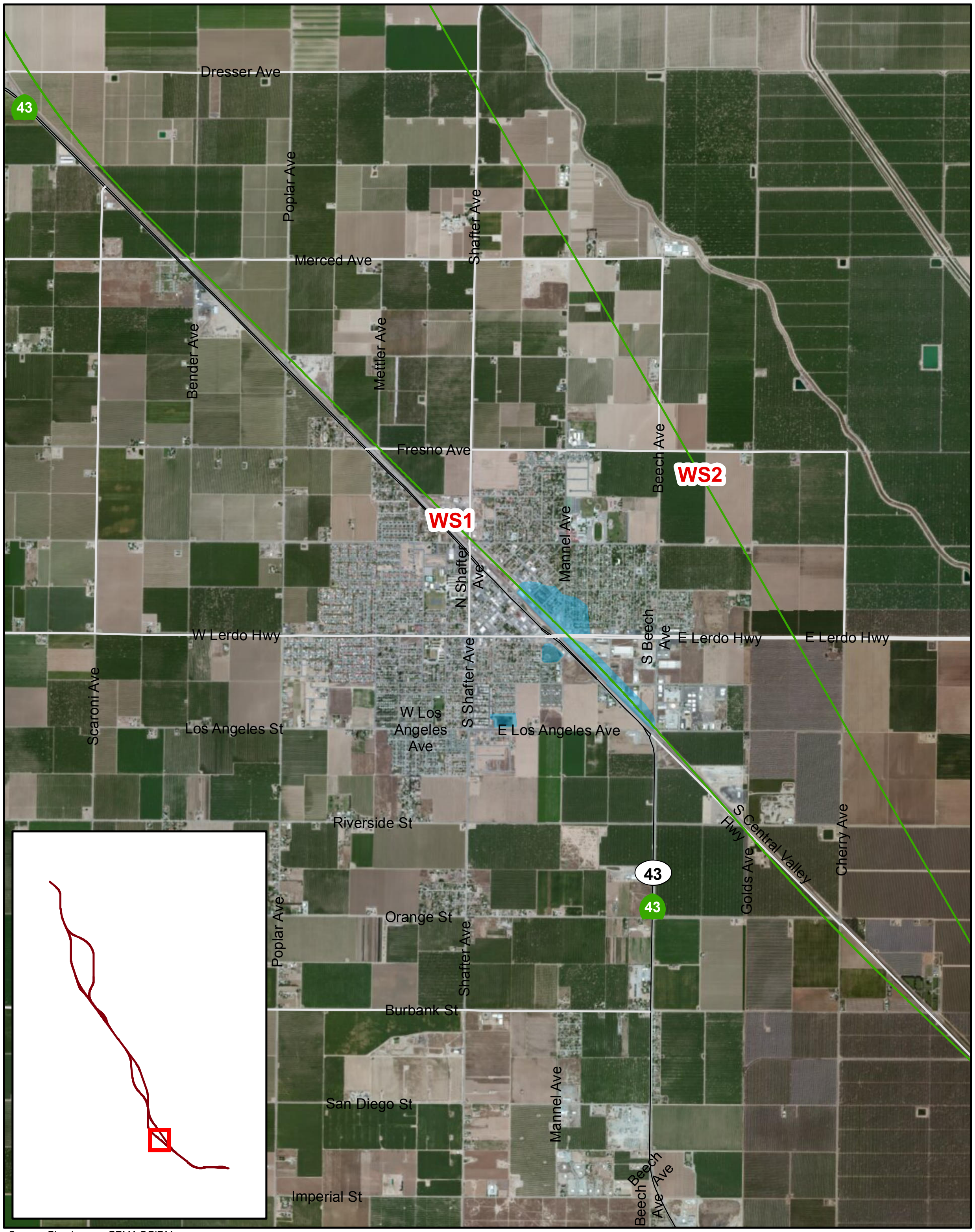
N

0 2,000 4,000
Feet

0 500 1,000
Meters

Figure 2.1-12

South of Poso Creek Floodplain



Source: Flood zone - FEMA DFIRM
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

December 2013

N

0 2,000 4,000
Feet

0 500 1,000
Meters

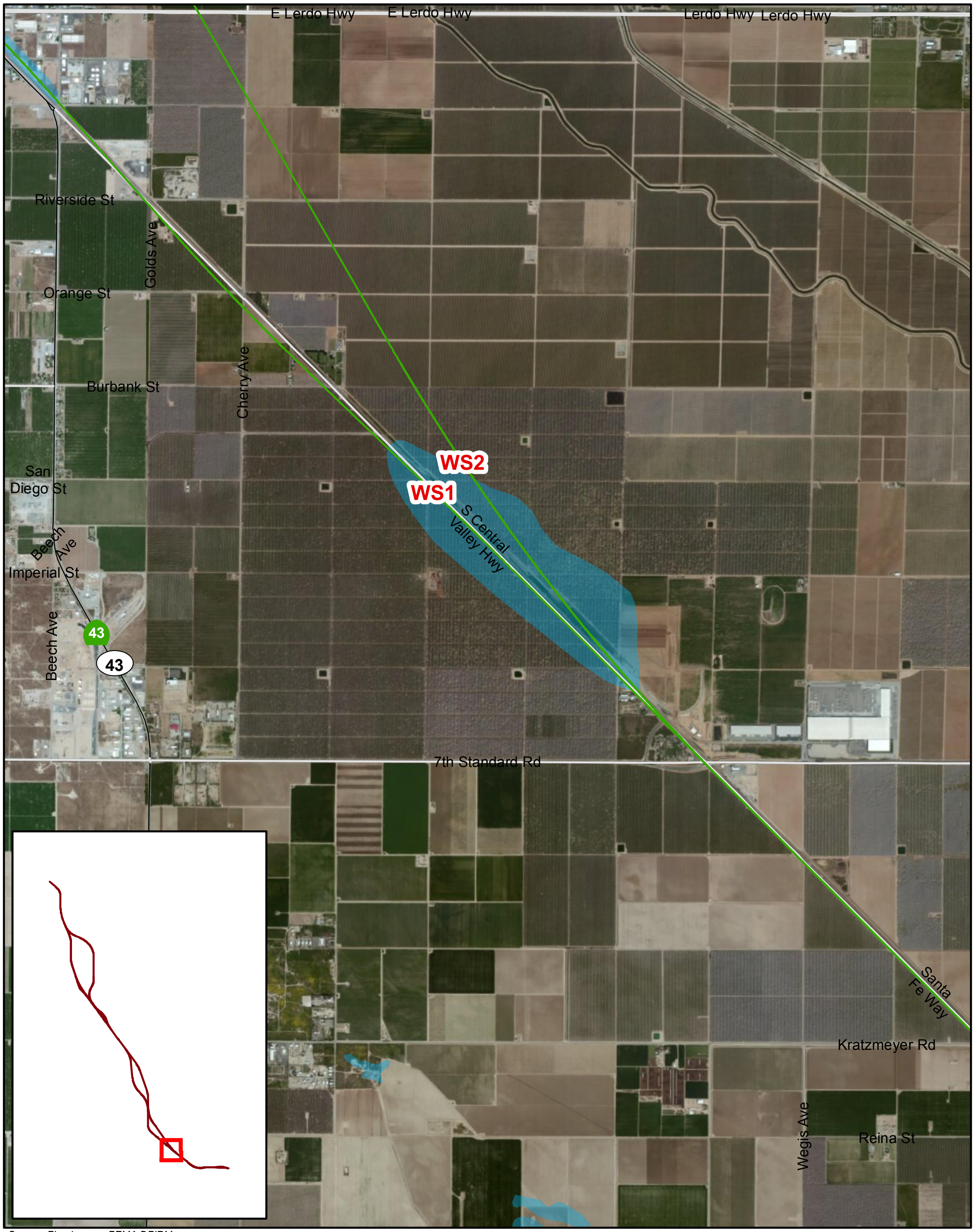
Legend

- CVFPB Designated_Floodways
- 100 Year Flood Zones

Alignment Alternatives

- F1
- M
- H, HW, HW2
- K1, K2, K3, K4, K5, K6
- C1, C2, C3
- P
- A1, A2
- L1, L2, L3, L4
- WS1, WS2
- B1, B2, B3

Figure 2.1-13
Shafter Floodplain



Source: Flood zone - FEMA DFIRM
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

December 2013

Legend

CVFPB Designated_Floodways

100 Year Flood Zones

Alignment Alternatives

- F1
- M
- H, HW, HW2
- K1, K2, K3, K4, K5, K6
- C1, C2, C3
- P
- A1, A2
- L1, L2, L3, L4
- WS1, WS2
- B1, B2, B3

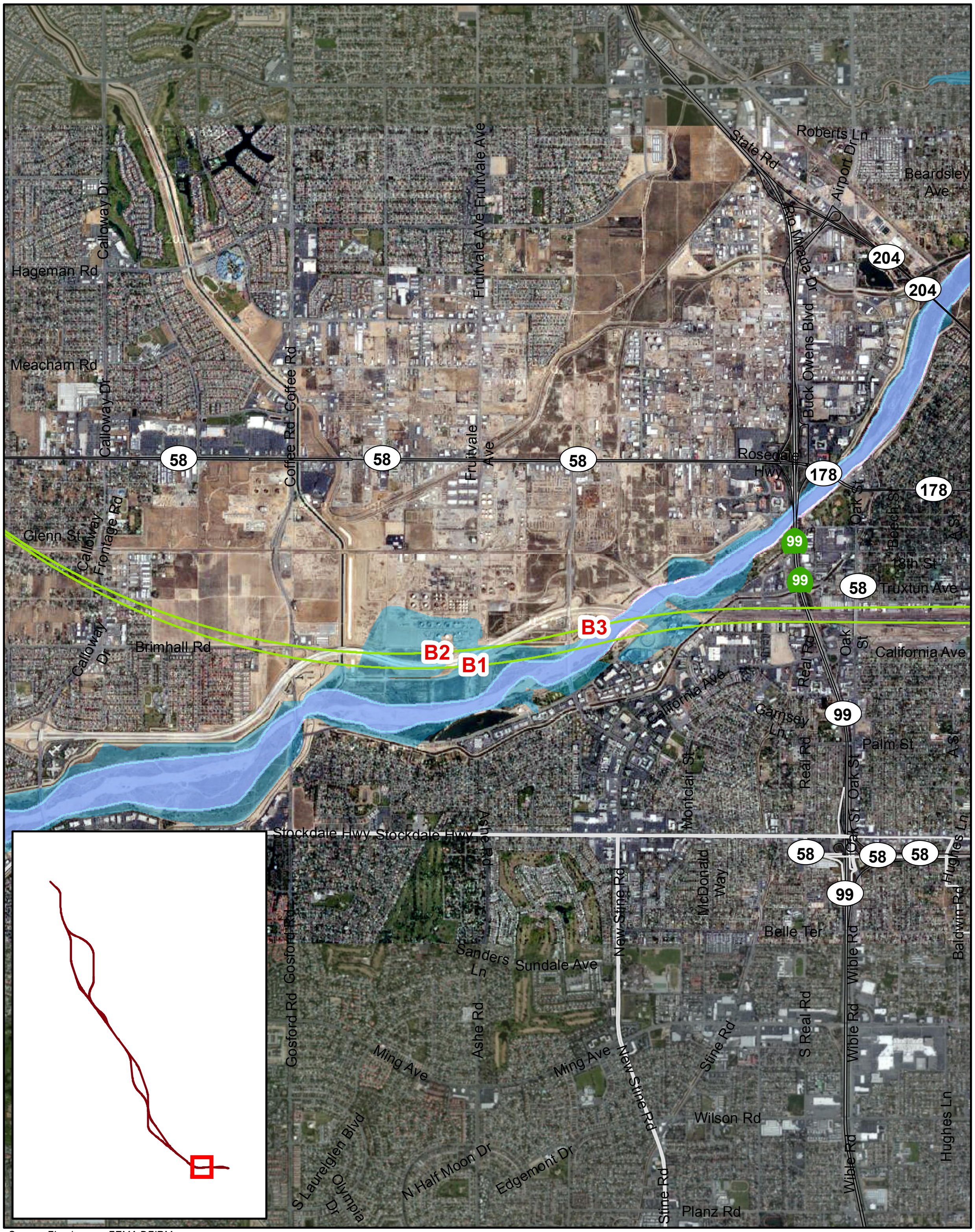
N

0 2,000 4,000
Feet

0 500 1,000
Meters

Figure 2.1-14

Weidenbach Street Floodplain



Source: Flood zone - FEMA DFIRM
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

December 2013

Legend

- CVFPB Designated_Floodways
- 100 Year Flood Zones

Alignment Alternatives

- F1
- M
- H, HW, HW2
- K1, K2, K3, K4, K5, K6
- C1, C2, C3
- P
- A1, A2
- L1, L2, L3, L4
- WS1, WS2
- B1, B2, B3

N

0 2,000 4,000
Feet

0 500 1,000
Meters

Figure 2.1-15

Kern River Floodplain

2.2 Floodplain Crossing Types

This section describes the three ways the HST will cross over a floodplain. Table 2.2-1 summarizes the expected types of floodplain crossings that would occur for each floodplain. Some alignments cross the same floodplain multiple ways. For instance, an alignment may be on embankment for some portion of the floodplain and then cross over a waterway within the floodplain on a structure. Refer to the *Hydrology, Hydraulics, and Drainage Report* for WSE estimates and recommended minimum HST elevations.

2.2.1 Rail on Embankment or Retaining Wall

HST tracks set on embankment or retained fill will have a minimum 2-foot clearance from the top of subgrade to the 100-year WSE. These sections will have sufficient openings/hydraulic crossing structures so that there is no significant impact to existing floodplains. Openings will be placed to coincide with openings in the adjacent BNSF embankment where applicable. Structures will be used over the waterways within the floodplain.

2.2.2 Rail in Trench Section

HST tracks set below grade will have conveyance systems to pass all floodwater from one side of the trench to the other. A siphon system is used in the Jenson trench on Alignment F1. The location and size of the siphon is included in Appendices A and B of the *Hydrology, Hydraulics, and Drainage Report*. A preliminary design of the siphon system is shown on the structural drawings.

2.2.3 Rail on Viaduct or Elevated Structure

HST tracks on elevated structures over floodplains will have a minimum 2-foot freeboard from the underside of the soffit to the 100-year WSE and will be designed so that there is no significant impact to the floodplain. In some cases, the alignment will cross a portion of the floodplain on a viaduct or elevated structure, while other portions of the alignment will cross through the floodplain on embankment.

Table 2.2-1
Proposed Types of Floodplain Crossings

Floodplain	On Embankment	In Cut or Trench	On Viaduct or Structure
Church Avenue	--	F1	--
North Central Canal			F1
Central Canal	--	--	F1
Kings River Complex	H, HW, HW2	HW2	H, HW, HW2
Cross Creek	K1-K6, C1, C2	--	K1-K6
Tule River	C2, C3	--	C1-C3
Deer Creek	P, A1, A2	--	P, A1, A2
County Line Creeks	A2	--	A2
Poso Creek	A1, L1-L4	--	L1-L4
Shafter	--	--	WS1
Weidenbach Street	WS1, WS2	--	WS2
Kern River	--	--	B1-B3

2.3 Floodplain Impacts and Potential Mitigation

For the purposes of the preliminary design, risks to floodplains due to the proposed project have been determined qualitatively, based on general knowledge of the area, available information, and preliminary hydraulic modeling. Hydraulic impacts of typical floodplain crossings include 100-year WSE and/or flow velocity increases, changes to the inundated area, and potential for scour at structures within the floodplain. Such changes may affect not only the natural and beneficial use of the floodplain but also existing development or infrastructure within the floodplain. Depending on the relative significance of each encroachment, such effects may range from insignificant to severe. Typically, a detailed hydraulic study is needed to quantify such effects and to recommend effective mitigation. For this preliminary report, hydraulic modeling was performed in a preliminary manner and for only the major waterways crossed by the alignment alternatives due to lack of site-specific data, including topographic information, existing structure elevation and geometry information, and in some cases, peak flow information. The preliminary hydraulic modeling and results are documented in the *Hydrology, Hydraulics, and Drainage Report*. Detailed modeling should be conducted during later stages of design as appropriate to provide additional information to further refine the risk assessment of each waterway.

A number of alignment alternatives are under consideration for the Fresno to Bakersfield Section. Hydraulic impacts, among other design considerations, will be considered in selecting a final alternative. Due to the number of constraints on the design, the alignment alternative with the least hydraulic impact may not necessarily be selected. Further information on the selection of alternatives and the specific hydraulic impacts of each will be ascertained as part of a future analysis.

2.3.1 Impacts

The majority of the floodplains crossed by the HST alignments have shallow flow or ponding 1 to 3 feet deep that spreads out over areas that are thousands of feet wide. This shallow flooding is primarily due to overflow of stream channels when high flows exceed the capacity of the channels. The resulting shallow flooding tends to be slow moving.

The general gradient of the land in the study area slopes to the west. The shallow, overland flooding tends to pond against canal berms, levees, and road embankments that are perpendicular to the land gradient. If these features lack adequate culverts or other means of cross drainage, the overland flows are sometimes diverted long distances before finally overflowing the linear obstacles and continuing their flow west.

The proposed HST alignments will be designed to accommodate the passage of flood flows. Adequate culverts and bridge openings for cross drainage will be placed at appropriate locations, matching where embankment already exist along adjacent projects. This will be important in preventing at-grade alignment embankments from excessively diverting shallow flood flows. The potential for worsening flood concerns is limited where the HST guideways are adjacent to existing embankments that already create a flood barrier. Potential new impacts are most likely to require mitigation where the HST guideway does not parallel existing railroad or highway embankments. Floodplain mitigation measures should generally allow adequate flood management for at-grade sections of tracks without requiring that the alignment be elevated solely for flood control purposes. Where the alignment is elevated, there is little potential to exacerbate flooding.

Apart from the wide, flat, low-gradient floodplains, the project would also cross several stream channels that have a higher hydraulic capacity. The higher flows in the stream and river channels are fundamentally different from the shallow, relatively slow-moving floodwater. Floodwater flows within channels involve deeper, faster-flowing water that can potentially erode stream banks and channel bottoms. If not properly designed, HST bridge piers and abutments have the potential to restrict flow in the channels and increase flood depths in adjacent reaches and at nearby structures. Bridge abutments and piers must be constructed at depths adequate to prevent their compromise and failure because of channel scouring during flood events.

Impacts on natural and beneficial floodplain values as a result of the construction of the HST are expected to be minimal. Natural and beneficial uses of floodplain areas include, but are not limited to, natural storage of floodwaters, river/floodplain interaction, habitat, and open space.

With the exception of the cities along the alignment from Fresno to Bakersfield, existing development is relatively sparse. Much of the land is under agricultural cultivation with residences, farming operations, and maintenance facilities located throughout. Hydraulic impact to existing development within floodplains will be insignificant. Future development within floodplains is not expected to be greatly influenced by construction and operation of the HST.

2.3.2 Infrastructure Impacts

This section provides a qualitative assessment of the risk of inundation and flood damage to existing facilities in the floodplain, including the BNSF rail line, irrigation and drainage facilities, levee systems, and roadways. In general, sufficient freeboard above the estimated 100-year WSE will be provided to prevent debris and bed loading impacts to either the HST or surrounding infrastructure, and to ensure maintenance access to existing channels and levee systems.

2.3.2.1 BNSF Railroad

The existing BNSF railroad embankment is not likely to experience any hydraulic impact from implementation of the proposed project. If the existing BNSF alignment is modified, existing cross

drainage conveyance will be maintained. Conveyance along the new HST alignment will be designed to prevent any hydraulic constriction and limit additional risk to the BNSF facility.

2.3.2.2 Irrigation and Agricultural Drainage Canals

Significant hydraulic impacts to irrigation and drainage channels crossed by the alignments are not anticipated. Most canals are less than 20 feet wide. These small canal crossings may employ culverts ideally sized to maintain open channel flow. For wider canals and those crossed at an angle, a structure may be employed.

The proposed alignments generally follow the existing BNSF rail line. For the purpose of the preliminary design, wherever the two lines are sufficiently close for waterway crossings to be hydraulically similar, the HST alignment will meet or exceed the hydraulic capacity of the existing BNSF rail line. Where the two alignments are not parallel, efforts have been made to identify a conservative sizing that will not generate hydraulic impacts for flow in either direction. Without detailed information on flows, these estimates are subject to change during later stages of design.

This report does not discuss the potential hydraulic impacts or mitigations associated with any canal relocations that may be necessary. Hydraulic evaluations for adjusted canals may be necessary in the future once preferred alignments have been finalized.

2.3.2.3 Levee Systems and Channel Maintenance

Local increases in WSE, velocity, and scour are possible within existing levee systems due to construction of the CHSTP. Impacts on levees will be avoided. To reduce the effects of debris and bed loading, the soffit of each crossing will be dictated by the greater of the height above existing levees needed for maintenance and the estimated flood WSE plus a minimum of 4 feet of freeboard. On crossings where there is a significant potential for hydraulic impact, viaduct and pier placement will be such that impacts are avoided.

2.3.2.4 Highways and Roadways

Highways and roadways throughout the valley will be affected by implementation of the proposed CHSTP. Significant hydraulic impacts are not expected overall. Increases in inundated areas and WSEs are not expected to be significant, due in part to the fact that most roadways in the vicinity are already slightly above the surrounding grade. In addition, overall hydraulic changes are not expected to be significant. Impacts such as access interruption, interruption or termination of communities, interruption of evacuation routes, or facilities needed for emergency vehicles are expected to be negligible.

2.3.3 Hydraulic Modeling

Preliminary hydraulic modeling was performed to evaluate the potential floodplain impacts for the major waterways and for each alignment alternative using HEC-RAS River Analysis System program Version 4.1.0 developed by the USACE. The hydraulic modeling was conducted based on the 15% Design Submission of the structural drawings and 100-year peak flow information documented in FEMA FISs to evaluate floodplain impacts. Table 2.3-1 lists WSE at the main channel based on the hydraulic modeling results.

Table 2.3-1
WSE from the Hydraulic Modeling

Waterway	FIS Q100 (cfs)	Alignment	100-year WSE[1] (feet)
Central Canal	350	F1	289.2
Kings River Complex	19,900	H	270.6
		HW & HW2	259.1
Cross Creek	19,200	K1 & K5	202.3
		K2 & K6	202.1
		K3	204.3
		K4	204.4
Tule River	20,500	C1, C2 & C3	196.4[2]
Deer Creek	500[3]	A1	197.2
		A2	197.5
Poso Creek	19,000	L1 & L2	304.0
		L3 & L4	304.4
Kern River	10,200/15,000[4]	B1	392.9–393.7[5]
		B2 & B3	393.5–395.4[5]

[1] WSE measured at location that the HST crosses the main channel
[2] The listed WSE is for the existing condition at the HST alignments.
[3] Full channel flow
[4] CVFPB 100-year peak flow
[5] WSE from CVFPB 100-year peak flow modeling

2.3.3.1 Central Canal

Alignment F1 is proposed to cross a 170-foot-wide FEMA 100-year floodplain (Zone AE) at Central Canal with a two-barrel 16-by-6-foot reinforced box culvert. The FEMA 100-year peak flow of 350 cubic feet per second (cfs) was used for the hydraulic modeling. This 100-year flow was obtained from FEMA FIS for Fresno County, California, and Incorporated Areas, dated February 18, 2009. The channel geometry was based on the project topographic map and adjusted according to the channel bottom elevations documented in the FEMA FIS profile to account for potential error of the project topographic map affected by water depth. The hydraulic model also includes a proposed two-barrel 16-by-6-foot reinforced box culvert crossing under the proposed Cedar Avenue vertical realignment, the existing northbound and southbound BNSF railroad bridges, and an irrigation flow control structure between the two proposed culverts. The geometries of the BNSF railroad bridges and the flow control structure were estimated based on field observations. Based on the hydraulic analysis, the HST impact on the 100-year WSE will not be significant (less than 0.1 feet) for both crossing locations.

2.3.3.2 Kings River Complex

A FEMA 100-year flow of 19,900 cfs was used for the Kings River floodplain hydraulic modeling. This 100-year flow was obtained from FEMA FIS for Tulare County, California and Incorporated Areas, dated June 16, 2009.

The hydraulic modeling covers the existing FEMA floodplain width, extending from approximately 4,700 feet upstream of the H Alignment to approximately 6,300 feet downstream of the HW and HW2 Alignments. The maps used for the HEC-RAS modeling of the floodplain consist of project topographic maps and LiDAR maps for areas outside the project topographic maps. Based on the hydraulic analysis, the HST impact on the 100-year WSE will not be significant (less than 0.1 feet) for both crossing locations.

2.3.3.3 Cross Creek

A FEMA 100-year flow of 19,200 cfs was used for the Cross Creek floodplain hydraulic modeling. This FEMA 100-year flow was obtained from FEMA FIS for Kings County, California and Incorporated Areas, dated June 16, 2009.

The hydraulic modeling is generally limited within the project mapping areas. The most upstream cross section is located approximately 2.5 river miles upstream of the BNSF Railroad alignment. The most downstream cross section is located approximately 2400 feet downstream of the BNSF Railroad. Most of the cross sections extend over the FEMA floodplain, which is close to 4 miles in width at the BNSF Railroad and the proposed HST alignments.

The maps used for the HEC-RAS modeling of the floodplain consist of project topographic maps, and interpolation of the topographic contour was applied where the project maps are not available. Channel bottom elevation was adjusted based on the profile information documented in the FEMA FIS report dated September 26, 2008. Based on comparison of the structure information, it was found out that the FIS report elevations are approximately 10 feet higher than the project mapping elevations. The profile elevation information from FIS report was reduced 10 feet for use in the HEC-RAS modeling.

The modeling results show that there will not be significant change (less than 0.1 feet) in the WSE at Cross Creek for the alignments, since there will be no pier column located in the channel.

2.3.3.4 Tule River

The C1 and C3 Alignments were designed to cross Tule River with a 240-foot-long bridge. The C2 Alignment crosses over Tule River, a portion of the floodplain on both sides of Tule River, and the BNSF railroad with a 5,666-foot-long viaduct. There is one pier in the river for all the three alignments. Due to lack of adequate topographic information, the hydraulic modeling for the floodplain was conducted in a preliminary manner and for the existing condition only. The model extends approximately 2,300 feet along the river, from 700 feet upstream of the SR 43 bridge to 1,400 feet downstream of the BNSF railroad bridge. A 100-year peak flow of 20,500 cfs was used for the modeling. This 100-year flow was obtained from FEMA FIS for Kings County, California, and Incorporated Areas, dated June 16, 2009. Based on the modeling results, the 100-year flood will overtop the SR 43 but will pass under the BNSF railroad through the bridge and three culverts within the floodplain. No 100-year flood modeling was done for this floodplain under the proposed condition. The proposed HST alignments provide bridge and culvert openings sized to match or exceed the BNSF openings to minimize impact on the floodplain.

2.3.3.5 Deer Creek

The A1 Alignment crosses Deer Creek and a portion of the floodplain south of Deer Creek with a 6,240-foot-long viaduct, and the A2 Alignment crosses Deer Creek and a portion of the floodplain south of Deer Creek with a 6,980-foot-long viaduct. There is one pier in the creek for both of the alignments.

Due to lack of 100-year peak flow information, the hydraulic modeling has been conducted only for full channel flow analysis to evaluate the impact of different pier configurations on pier scour depth. The results were provided for the structure foundation design of the proposed alignments.

2.3.3.6 Poso Creek

Alignments L1 to L4 cross the FEMA 100-year floodplain (Zone A) at Poso Creek. The L1 and L3 Alignments were designed to cross Poso Creek with a 240-foot-long bridge. The L2 Alignment has a 6,550-foot-long elevated viaduct, which starts from the north bank of Poso Creek and crosses Poso Creek, its floodplain on the south overbank, and the BNSF railroad. The L4 Alignment was designed to cross over Poso Creek with a 240-foot-long bridge and has a 6,620-foot-long elevated viaduct to cross the majority portion of the floodplain on the south overbank and the BNSF railroad.

Hydraulic modeling for Poso Creek was based on limited topographic information, including a project topographic map and contours along the existing BNSF railroad. The 100-year peak flow of 19,000 cfs was documented in FEMA FIS for Kern County, California and Incorporated Areas, dated June 26, 2008, for a location at SR 58.

The preliminary hydraulic analysis shows that for a flood of 19,000 cfs, only a small portion of the flow could pass through the existing railroad bridge at Poso Creek. The remaining flow that will be intercepted behind the railroad embankment will flow continuously north, overtopping the railroad at locations about 1 mile and 2 miles north of Poso Creek. The overtopped flow from the BNSF embankment will approach the proposed HST alignment beyond the FEMA 100-year floodplain boundary. Multiple hydraulic crossings were proposed along Alignments L1 to L4 as well as a south section of A1 and A2 Alignments, to allow the flow to pass through.

2.3.3.7 Kern River

Both FEMA and CVFPB 100-year peak flows were used for the hydraulic modeling. The FEMA 100-year flow of 10,200 cfs was obtained from FEMA FIS for Kern County, California and Incorporated Areas, dated June 26, 2008. The CVFPB 100-year peak flow of 15,000 cfs is from the CVFPB Designated Floodway Program, dated September 6, 1990.

The hydraulic modeling is generally limited within the project mapping areas. The most upstream cross section is located approximately 1,270 feet upstream of the BNSF Railroad alignment. The most downstream cross section is located approximately 400 feet upstream of Coffee Road. Most of the cross sections extend over the FEMA floodplain, which is close to 4,000 feet in width at the widest location within the study area.

Based on the hydraulic modeling results, the proposed B1 Alignment will cause up to 0.23-foot rise in the channel for either the FEMA 100-year flow or the CVFPB 100-year flow, while B2 and B3 Alignments will cause up to 0.42-foot rise in the channel for the FEMA 100-year flow and up to 0.56-foot rise in the channel for the CVFPB 100-year flow.

2.3.4 Mitigation in Floodplains

2.3.4.1 Culverts

The project should include culverts with sufficient capacity and at a sufficient spacing to prevent substantial ponding against the upslope side of the guideway embankment and project roadway embankments that could result in deeper ponded conditions and/or lateral diversion of shallow flooding. However, the location, spacing, and size of existing culverts through adjacent railroad and highway embankments limit the effectiveness of culverts in reducing local flooding. Where there are opportunities to improve the combined culvert performance, stormwater hydromodifications and objectives should be evaluated.

Portions of each of the HST alternative alignments are adjacent to one or more existing railroad embankments. The specific locations and spacing of the HST guideway embankment culverts that would be developed during the detailed design must account for local topography and shallow flooding

conditions. At a minimum, culverts should match those through the adjacent railroad embankment. However, additional culverts may be required to avoid known ponding or flow diversion problems.

To accommodate potential future flood improvements, the project could install additional culverts where it is determined that the existing embankment has inadequate flood passage facilities. This would allow hydraulic constrictions to be corrected in the future when the existing, upgradient railroad tracks are upgraded or abandoned.

Inlets and outlets should be protected at crossings. Wing walls, riprap, or similar protection should be placed to protect the guideway embankment and outlet channel from possible erosion. Culverts would also be needed where new project road embankments or other elevated project facilities impede floodplain flows.

2.3.4.2 Structures

Hydraulic impacts at all HST crossings will be minimized by providing hydraulically smooth transitions under the HST alignment, by minimizing the fill in the floodplain, and by utilizing the longest practicable span to cross the main channel (defined by Caltrans as channel width measured at the ordinary high-water mark) of the waterway. Due to the limited possible span length between support columns and the width of the main channels, even if spanned by a viaduct, one or more piers are likely to be placed in the main channels of Cole Slough, Dutch John Cut, the Kings River, Cross Creek, Tule River and the Kern River. However, no substantial impact (greater than 1 foot) to the 100-year WSEs of these channels is foreseen.

2.3.4.3 Scour

Because of the shallow slope of the valley floor from Fresno to Bakersfield, flow velocities and therefore scour are generally not anticipated to be a significant problem for most floodplains. In general, scour is more likely to be significant in the main channel of each waterway than in the floodplain. The pier scour depth is anticipated to be in the 15- to 32-foot range for the main channels of the major rivers and creeks for a 100-year storm event, depending on the crossing location of the waterway and the pier column size, shape, and configuration. It is recommended that the footings and foundation piles be placed below the long-term and general scour depth. Transitions will be designed to be hydraulically smooth, and countermeasures against thalweg erosion and local and contraction scour will be considered.

Section 3.0
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